Surveys of Soft-Shell Clam
(Mya arenaria)
Populations in Some Closed Areas of Charlotte County, New Brunswick

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SURVEYS OF SOFT-SHELL CLAM (*MYA ARENARIA*) POPULATIONS IN SOME CLOSED AREAS OF CHARLOTTE COUNTY, NEW BRUNSWICK

by

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ABSTRACT

Robert, G., and D.W. Smith. 1980. Surveys of soft-shell clam (Mya arenaria) populations in some closed areas of Charlotte County, New Brunswick. Can. MS Rep. Fish. Aquat. Sci. 1567: 59 p.

Assessments of soft-shell clam stocks were carried out in the closed shellfish growing areas of Charlotte County, New Brunswick. Tidal flats were surveyed in Oak Bay, Passamaquoddy Bay, Digdeguash Harbour, Letang Harbour, Beaver Harbour, and Maces Bay. Stocks of clams were present in considerable numbers over the areas surveyed. It is estimated that 1,000 mt of clams in the shell could be harvested. The clam producing grounds surveyed have very heterogeneous environments and huge variations occur in clam concentrations over a short distance.

Key words: fishery, shellfish, soft-shell clam, Bay of Fundy.

RESUME

Robert, G., and D.W. Smith. 1980. Surveys of soft-shell clam (Mya arenaria) populations in some closed areas of Charlotte County, New Brunswick. Can. MS Rep. Fish. Aquat. Sci. 1567: 59 p.

On inventoria les populations de myes des zones de coquillages fermées à la pêche dans le comté de Charlotte, Nouveau-Brunswick en étudiant les battures d'Oak Bay, Passamaquoddy Bay, Digdeguash Harbour, Letang Harbour, Beaver Harbour, et Maces Bay. On y trouva des populations de myes d'importance. Il est possible d'y récolter 1,000 tm de myes en coquille. Ces myères sont charactérisées par un milieu très hétérogène et les densités de myes subissent des variations importantes sur une courte distance.

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INTRODUCTION

Population surveys for soft-shell clam (Mya arenaria) were carried out on tidal flats between Oak Bay and Maces Bay, Charlotte County, New Brunswick (Figure 1) from January to July, 1974. Shellfish harvesting is prohibited in approximately 75% of the shellfish growing areas in Charlotte County because of contamination by domestic sewage. This survey was to determine if there were sufficient stocks of commercial interest in these closed areas to support depuration facilities.

MATERIALS AND METHODS

Using the closure line as a heading, baselines were run parallel to it at 200-foot (61 m) intervals from the mean low tide level to the mean high tide level. These baselines were sampled at 100-foot (30 m) intervals. Clam flats less than 15 acres (60.5 ha) were sectioned by baselines at 100-foot intervals sampled every 50 feet (15 m). All distances were measured with a chain marked at 50- and 100-foot intervals. Baseline directions were determined by using a Silva Type 15T Ranger Field Lighting Compass. Acreage of areas sampled was estimated by the aerograph method.

Samples were taken from 1 ft^2 (0.09 m^2) of substrate to a depth of 20 cm. This is below the maximum depth at which soft-shell clams are generally found. The beach was dug up with a clam hack or square nose shovel, depending on the type of substrate. Clams over 20 mm long were collected and returned to the laboratory for examination; juveniles are therefore not adequately represented. Each area was sampled once.

Size frequency distributions were constructed from clam lengths, and condition indices were calculated from weights. The nature of the beach substrate was noted. Length to the nearest millimeter was measured between the farthest points of the shell, using a vernier caliper. Clams from each sample were divided into 5-mm size classes.

For condition index, weights were recorded to the nearest 0.1 g using a laboratory balance. Condition indices used to determine meat quality were calculated as follows:

$$\frac{\text{dry meat weight}}{\text{live clam weight - shell weight}} \times 1{,}000$$

Dry weights of meats were determined by placing animal tissues of clams over 30 mm long in an oven at 65°C for 48 hours. The condition indices were ranked according to Medcof (1961),

150-100: high quality
99-80 : medium quality
< 80 : low quality

The conventional harvesting technique, digging by clam hack, was determined to be 60% efficient in a number of substrates (Medcof and MacPhail, 1964). Thus, the size of the resource available to a fishery was computed to be 60% of the number of bushels of clams 30 mm and longer estimated to be present in an area.

RESULTS

A summary of the survey data is given in Table 1. The size of the area sampled, the modal size classes present, and the number of bushels (27.3 kg/bu) of clams (> 30 mm) for each area are shown. The areas are listed in geographical order starting at the Maine-New Brunswick border and going up the Bay of Fundy. The areas surveyed are ranked in Table 2 in decreasing order, based on the number of bushels of clams per acre (40.47 ha).

More detailed information on each area is given below, by section where applicable. Areas were divided into sections because of the heterogeneity of the environment (nature of the substrate, flow pattern, etc.). The areas are listed in geographical order as previously stated.

Oak Bay

Oak Bay is a small bay which branches out from the St. Croix River at the Maine-New Brunswick border (Figure 1). The substrate is mainly sand and mud with some silt in the center of the intertidal zone. As a result of the silt, more clams are found high in the intertidal zone. The eastern shore of the Bay was divided into nine sections numbered from north to south; they were surveyed at the end of July, 1974 (Figure 2). The overall average of the meat condition index for clams from this area was 70.

Section I. No data available

Section II. This area consisted of 17 acres. The 35-40 mm size class is the main mode of the clam population sampled. A secondary mode occurs at the 20-25 mm size class (Figure 3). It was estimated that 19 bushels per acre could be harvested from this section.

Section III. This section covered 44 acres. The modal size range of clams was 35-50 mm, making up over 50% of the total population sampled (Figure 4). The harvestable standing stock from this section was estimated at 30 bushels per acre.

Section IV. This was an area of 14 acres. Clams were large with the modal size range being 40-55 mm (Figure 5). Only 25% were less than 40 mm long. The harvest from this section could be 38 bushels per acre.

Section V. The size of this section was estimated at 8 acres. The modal size range was 30-50 mm, with very few larger clams (Figure 6). An estimated 30 bushels per acre could be harvested from this section.

Section VI. The area of this section was established at 47 acres. The largest size range was 30-50 mm; clams over 50 mm accounted for only 10% (Figure 7). The harvest from this section could be 40 bushels per acre.

Section VII. The size of this section was estimated at 18 acres. The majority of the clams collected were 35-50 mm long with a few larger than 50 mm (Figure 8). It was estimated that 58 bushels per acre could be harvested from this section.

Section VIII. This area was estimated at 62 acres. Few clams were greater than 50 mm long. The major size range was 30-50 mm (Figure 9). This section had an estimated harvest of 41 bushels per acre.

Section IX. This section covered about 17 acres. Clams had a unimodal distribution (40-50 mm size class) with few larger than 50 mm. The 35-40 mm size class represented 30% of the stocks sampled (Figure 10). The harvestable standing stock was estimated at 42 bushels per acre.

Pagan Cove

Pagan Cove is a small inlet on the western side at the mouth of Oak Bay (Figure 1). Most of the clams were found near the shore with none in the middle because of mud. The animals tend to be small, less than 35 mm long. The Cove was divided into six sections (Figure 2) which were sampled at the end of July, 1974. The average meat condition index for these clams was 70.

Section I. This was an area of approximately 10 acres at the head of the Cove. This clam population had one mode, 40-50 mm size class, with few clams exceeding 50 mm (Figure 11). This section had an estimated harvestable standing stock of 37 bushels per acre.

Section II. This section covered about 12 acres on the northern shore. Very few clams larger than 50 mm were found while most clams were 30-50 mm long (Figure 12). The harvest for this area could be 24 bushels per acre.

Section III. This area consisted of about 16 acres. The clam population was unimodal (35-50 mm), with few clams smaller or larger than this (Figure 13). The harvest for this area could be 34 bushels per acre.

Section IV. On the south shore next to Section I, this section covered an area of about 10 acres. Most of the clams were small, between 25-35 mm long; no clams were longer than 50 mm (Figure 14). This section had a potential harvest of 8 bushels per acre.

Section V. The size of this section was estimated at about 9 acres. Most of the clams were small, with few larger than 35 mm and none over 50 mm (Figure 15). The population had an important mode represented by the 30-35 mm size class. It would be possible to harvest 3 bushels per acre in this area.

Section VI. This section consisted of 11 acres. All samples contained small clams with none larger than 35 mm (Figure 16). The harvest here was estimated at less than 1 bushel per acre.

St. Andrews

The St. Andrews area is located on a point of land jutting into Passamaquoddy Bay and bordered on the west side by the mouth of the St. Croix River (Figure 1). The area is easily accessible by road and the beach is generally mud and sand with gravel at higher levels. The area was divided into four sections (Figure 17) which were surveyed at the end of April, 1974.

Section I. This was an area of about 59 acres located to the east of North Point. The modal size class of the clams collected was 40-50 mm. About equal quantities of clams larger than 55 mm and smaller than 35 mm were also found (Figure 18). The average meat condition index was 90. This section had a potential harvest of 31 bushels per acre.

Section II. This section covered an area of 44 acres which extended to Pagan Point. Most of the clams here were large, with 25% of those sampled longer than 50 mm. The modal size range was 35-50 mm (Figure 19). The clams sampled had an average meat condition index of 95. The estimated harvest for this area could be 57 bushels per acre.

Section III. This section covered about 21 acres, starting from Pagan Point. Most of the clams sampled were large with a mode at 40-50 mm. Over 25% of the stocks was made up by clams over 55 mm (Figure 20). The clams had an average meat index of 85. The harvest for this area could be 59 bushels per acre.

Section IV. No clams were found in this area as the beach substrate consisted of hard-packed gravel.

Boom's Cove

Boom's Cove is an inlet on the western shore of Digdeguash Harbour, a small harbour on the northern part of Passamaquoddy Bay (Figure 1). This is a somewhat isolated area with a sparse clam population. Only one section of the Cove (7 acres) was surveyed (Figure 21). The substrate was rocky high on the beach, whereas the middle and lower sections were mud and sand. These stocks had a strong unimodal distribution (40-50 mm), with few clams longer than 50 mm and only 2% of those sampled less than 30 mm (Figure 22). These clams, sampled in mid March, had an average meat index of 95. The section had a potential harvest of 40 bushels per acre.

Magaguadavic River

The Magaguadavic River empties into the east side of Passamaquoddy Bay (Figure 1). The beach substrate of the areas surveyed was generally mud and sand.

The north shore of the River was divided into four sections (Figure 23) which were sampled in early May. The clams had an average meat index of 90.

Section I. This area consisted of about 24 acres. A mode, the 40-50 mm size class, was encountered with many clams longer than 50 mm (Figure 24). Few clams were smaller than 35 mm. The estimated harvest for this section could be 34 bushels per acre.

Section II. This section covered about 14 acres. The modal size range of clams sampled was 35-50 mm. Some clams were larger than 50 mm (Figure 25). This section had an estimated harvestable stock of 13 bushels per acre.

Section III. This area covered about 7 acres. These stocks were characterized by a strong unimodal distribution (40-50 mm size class) (Figure 26). The estimated harvest for this section could be 66 bushels per acre.

Section IV. The size of this section was about 6 acres. Most of the clams were 40-50 mm long, with some clams longer than 50 mm (Figure 27). A mode of lesser importance represents the 30-35 mm size class. The estimated harvest for this section could be 45 bushels per acre.

The south shore of the Magaguadavic River was divided into six sections (Figure 23) which were surveyed between March and June.

Section I. This section covered an area of about 89 acres. The 40-50 mm size class constituted an important mode, with some clams longer than 50 mm (Figure 28). Few clams were less than 30 mm long. The average meat index was 100. The area had a potential harvest of 72 bushels per acre.

Section II. The size of this section was about 6 acres. A strong unimodal distribution characterized these stocks (40-50 mm size class), with few clams longer than 50 mm or smaller than 30 mm (Figure 29). The clams sampled had an average meat index of 80. The harvestable standing stock for the area was estimated at 117 bushels per acre.

Section III. This section covered a little more than 14 acres. The modal size class of the clams sampled was 40-50 mm. A few clams were longer than 50 mm, while many were smaller than 35 mm (Figure 30). The meat index was 85-90. The estimated harvest for this section could be 119 bushels per acre.

Section IV. This section was a little less than 2 acres in size. Most of the clams were 40-50 mm long with many larger than 50 mm (Figure 31). A secondary mode was illustrated by the 30-35 mm size class. The average meat index was 80. This section had an estimated harvest of 128 bushels per acre.

Section V. This section covered about 22 acres. The modal size class of clams sampled was 40-50 mm, with few clams larger than 50 mm. Some clams smaller than 35 mm were found (Figure 32). The average meat condition index was 90. The harvestable stocks were estimated at 22 bushels per acre.

Section VI. This section covered about 12 acres. The modal size class of clams sampled was 40-50 mm. About 25% of those sampled were longer than 50 mm, while about 15% were smaller than 35 mm (Figure 33). The average meat index of clams taken from this area was 85-90. This section had a potential harvest of 36 bushels per acre.

Cricket Flats

Cricket Flats is a small cove situated on the east side of Letang Harbour (Figures 1 and 34). The upper and middle beach have suitable bottoms for digging, while the lower beach is heavy mud. One section covering about 19 acres was surveyed in mid August. Clams were generally small, less than 40 mm and scattered. The modal size range was 30-40 mm; a secondary mode of lesser importance represented the 50-55 mm size class (Figure 35). The average meat index was 75. This area had an estimated harvest of 20 bushels per acre.

Sturgeon Cove

Sturgeon Cove is a small inlet on the southeast side of Letang Harbour, close to the town of Black's Harbour (Figures 1 and 34). Mud and sand were encountered on this tidal flat, with heavy mud in the center portion. The Cove was divided into three sections (Figure 34) which were surveyed in mid August. The average meat index for clams from the Cove was 85.

Section I. This area covered about 11 acres. The mode of clams sampled was 40-50 mm, with very few clams longer than 50 mm. Most of the clams were less than 40 mm long (Figure 36). The harvestable standing stock for this section was 12 bushels per acre.

Section II. This was a section of about 9 acres. These stocks were characterized by a strong unimodal distribution (40-50 mm size class) with a secondary mode, the 25-30 mm size class (Figure 37). The estimated harvest could be about 8 bushels per acre.

Section III. This section was about 23 acres. The 40-50 mm size class formed a mode with some clams longer than 50 mm (Figure 38). The estimated harvest for this section could be 27 bushels per acre.

Deadman Harbour

Deadman Harbour is a small harbour off the Bay of Fundy, east of Letang Harbour (Figures 1 and 34). Three sections of the Harbour were surveyed (Figure 34) where the substrate consisted of sand and gravel. All samples were collected in late May.

Section I. This section, above the bridge, covered about 18 acres. The modal size range of clams sampled was 35-50 mm. Some clams were longer than 50 mm, while most were smaller than 35 mm (Figure 39). The average meat index for clams from this section was 100. This area had a harvestable standing stock of 13 bushels per acre.

Section II. This section covered an area of approximately 19 acres. Over 50% of the clams collected were less than 40 mm long with only a few larger than 50 mm (Figure 40). The average meat index for clams from this section was 90. The estimated harvest could be 33 bushels per acre.

Section III. This was an area of almost 6 acres. Most clams were 35-55 mm long, with many longer than 55 mm (Figure 41). This section had a potential harvest of 24 bushels per acre. No meat index data are available.

Buckman's Creek

Buckman's Creek empties into Beaver Harbour at its northern end (Figures 1 and 34). One section of the Creek (Figure 34) was sampled in April and May. The modal size class of the samples was 40-50 mm, with a few clams longer than 50 mm. Half of the clams were less than 40 mm long (Figure 42). The average meat index was 85. The area surveyed covered about 23 acres with a potential harvest of 37 bushels per acre.

Woodland

Woodland is a small cove at the head of Beaver Harbour to the northeast (Figures 1 and 34). One section of about 20 acres was sampled in late May (Figure 34). The substrate consisted mainly of mud and sand. The 40-50 mm size class was the most abundant, with a relatively equal amount of larger and smaller clams (Figure 43). The average meat condition index for these clams was 115. This area had a harvestable standing stock of 32 bushels per acre.

Seeley Redhead

Seeley Redhead is a headland jutting out from the coast, west of Penn Island, into the Bay of Fundy (Figures 1 and 44). One section of about 8 acres was sampled (Figure 44). Most of the beach was rock ledges and soft mud, which is poor substrate for clams. Half of the clam population was in the 35-50 mm size range, with many clams smaller than 35 mm (secondary mode, 25-30 mm) and very few longer than 50 mm (Figure 45). No meat index data are available. The potential harvest for this area was 37 bushels per acre.

Redhead Harbour

Redhead Harbour is a small inlet off the Bay of Fundy to the northeast of Seeley Redhead (Figure 1). One section of about 37 acres was surveyed (Figure 44). Most of the clams sampled were smaller than 40 mm in this unimodal population (mode 40-50 mm) (Figure 46). The harvest for this area could be 52 bushels per acre. No information on the nature of the substrate or meat index are available.

Pocologan Harbour

Pocologan Harbour is a small inlet on the western side of Maces Bay (Figures 1 and 44). One section of about 110 acres was sampled in late February (Figure 44). Mud covered those tidal flats extensively. The 30-35 mm size class constituted a mode but many clams longer than 50 mm were also found (Figure 47). The average meat index was 90. The harvest for this area could be 27 bushels per acre.

DISCUSSION

The results of this survey identified the south shore of the Magaguadavic River as an excellent shellfish growing area with well over 100 bushels per acre of shellstock longer than 30 mm, particularly Sections I and III. Other productive areas of importance (over 75 bushels per acre) were the St. Andrews region and Redhead Harbour. Tidal flats around the St. Andrews peninsula had 125 acres of very good clam producing grounds. The other areas, as ranked in Table 2, were found to be good (Boom's Cove - Seeley Redhead) to poor (Sturgeon Cove). All these clam producing grounds had very heterogeneous environments and huge variations occurred in densities of clams from one section to the next within the same location.

For all the areas surveyed, clams over 30 mm long were present in considerable numbers, with an approximate harvestable biomass of 36,270 bushels (1,000 mt). Over 75% of these stocks were concentrated in the Oak Bay/ St. Andrews/Magaguadavic River mouth region.

In 1947-48 MacPhail (1949) conducted an extensive though cursory study of clam flats from Lepreau Basin to the U.S. border including Grand Manan and Deer Islands. It is very difficult to compare results from surveys performed 25 years apart, notwithstanding differences in assessment techniques. Nevertheless, St. Andrews qualified as a good producer then, and again in 1974.

Some biological facts may be outlined from the results of these surveys. Recruitment seems to be irregular in most of these stocks. Even though this survey was not concerned with juveniles (< 20 mm), the absence or very small number of clams 20-30 mm long indicates sporadic and patchy setting which may at times be coupled with poor survival of juveniles. If it is warranted, monitoring of these stocks by future surveys would give a better idea of the dynamics of the clam populations and the mechanisms involved.

Growth of soft-shell clams is slow in the Bay of Fundy region because of a short growing season from May to August inclusive (Newcombe, 1935). Five growing seasons are required to reach a commercial size (50 mm length) (Newcombe, 1935). Older animals grow only a few mm per year. In some cases, as revealed in the size-frequency distribution of Oak Bay, Pagan Cove, and Buckman's Creek, clam growth is stunted (Figures 3 to 16 and 42). Only the odd clam reaches lengths greater than 55 mm. This was also noticed by MacPhail (1949), especially at high levels of the tidal flats where thick concentrations of small but old clams occur. Newcombe (1935) established that in these conditions a clam would measure 35 mm after seven growing seasons. He further demonstrated that the rate of growth varies directly with time of submergence.

The meat condition index is directly related to the quantity of meat in the shellfish; a high index suggesting a high meat yield. It varies considerably through the areas sampled. This is due primarily to the collection time of the samples. The condition index is usually low in the spring, increasing in late spring and early summer when the meat becomes firm and the gonad ripe. It drops in July at spawning time in animals with spent gonads. After spawning the meat condition improves (Table 3).

The harvestable biomass as outlined by this survey could support a depuration facility. However, other aspects have to be considered. From a biological point of view, a viable operation requires a broader data base, including notions of sustainable yield and a better idea of recruitment patterns. Over the long term, is the bacteriological quality of the closed areas likely to improve or worsen? It should also be noted that only marginally contaminated stocks can depurate successfully (Rowell et al., 1976). What is the proportion of closed areas suitable for depuration? Economic considerations are in order too. Depurated clams have to stand competitive prices to sustain a profitable business. The presence of P.S.P. (Paralytic Shellfish Poisoning) could jeopardize a plant operation by close-down periods during the summer months.

REFERENCES

MacPhail, J.S. 1949. Survey of clam flats - Charlotte County, New Brunswick. 1947 and 1948. Fish. Res. Bd Can. MS Rept. No. 748: 73 p.

Medcof, J.C. 1961. Oyster farming in the Maritimes. Fish. Res. Bd Can. Bull. No. 131: 158 p.

Medcof, J.C. and J.S. MacPhail. 1964. Fishing efficiency of clam hacks and mortalities incidental to fishing. Proc. Nat. Shellfish. Assoc. 55: 53-72.

Newcombe, C.L. 1935. Growth of Mya arenaria L. in the Bay of Fundy region. Can J. Res. 13D(6): 97-137.

Rowell, T.W., G. Robert, K.B. Swansburg, and R. Davis. 1976. Soft-shell clam depuration, Digby, Nova Scotia. Fish. Mar. Serv. Res. Dev. Tech. Rept. No. 687: 121 p.

Table 1. Summary of *Mya* survey results for Charlotte County, New Brunswick.

Area	Acres	Modal size classes present (mm)	Total number of bushels ≥ 30 mm	Bushels/acre ≥ 30 mm
Oak Bay	227	30-50	14,263	62
Pagan Cove	67	30-50	2,138	30
St. Andrews	125	35-50	9,258	81
Boom's Cove	7	40-50	431	66
Magaguadavic River North	51	35-50	2,934	66
Magaguadavic River South	146	35-45	16,666	137
Cricket Flats	19	30-50	628	33
Sturgeon Cove	43	40-50	1,375	26
Deadman Harbour	43	30-50	1,651	39
Buckman's Creek	23	30-50	1,385	61
Woodland	20	35-50	1,105	54
Seeley Redhead	8	30-40	500	61
Redhead Harbour	37	30-40	2,291	79
Pocologan	110	30-40	4,916	45

Table 2. Areas sampled ranked in decreasing order according to the estimated number of bushels/acre.

Rank	Area	Buchels/acre ≥ 30 mm
1	Magaguadavic River South	137
2	St. Andrews	81
3	Redhead Harbour	79
4	Boom's Cove	66
4	Magaguadavic River North	66
5	Oak Bay	62
6	Buckman's Creek	61
6	Seeley Redhead	61
7	Woodland	54
8	Pocologan	45
9	Deadman Harbour	39
10	Cricket Flats	33
11	Pagan Cove	30
12	Sturgeon Cove	26

Table 3. Values of meat condition through the growing season for some areas

Condition index	Collection time	Area
90	late February	Pocologan Harbour
95	mid March	Boom's Cove
85-95	end of April	St. Andrews
90-100	late May	Deadman Harbour
70	end of July	Oak Bay
85	mid August	Sturgeon Cove

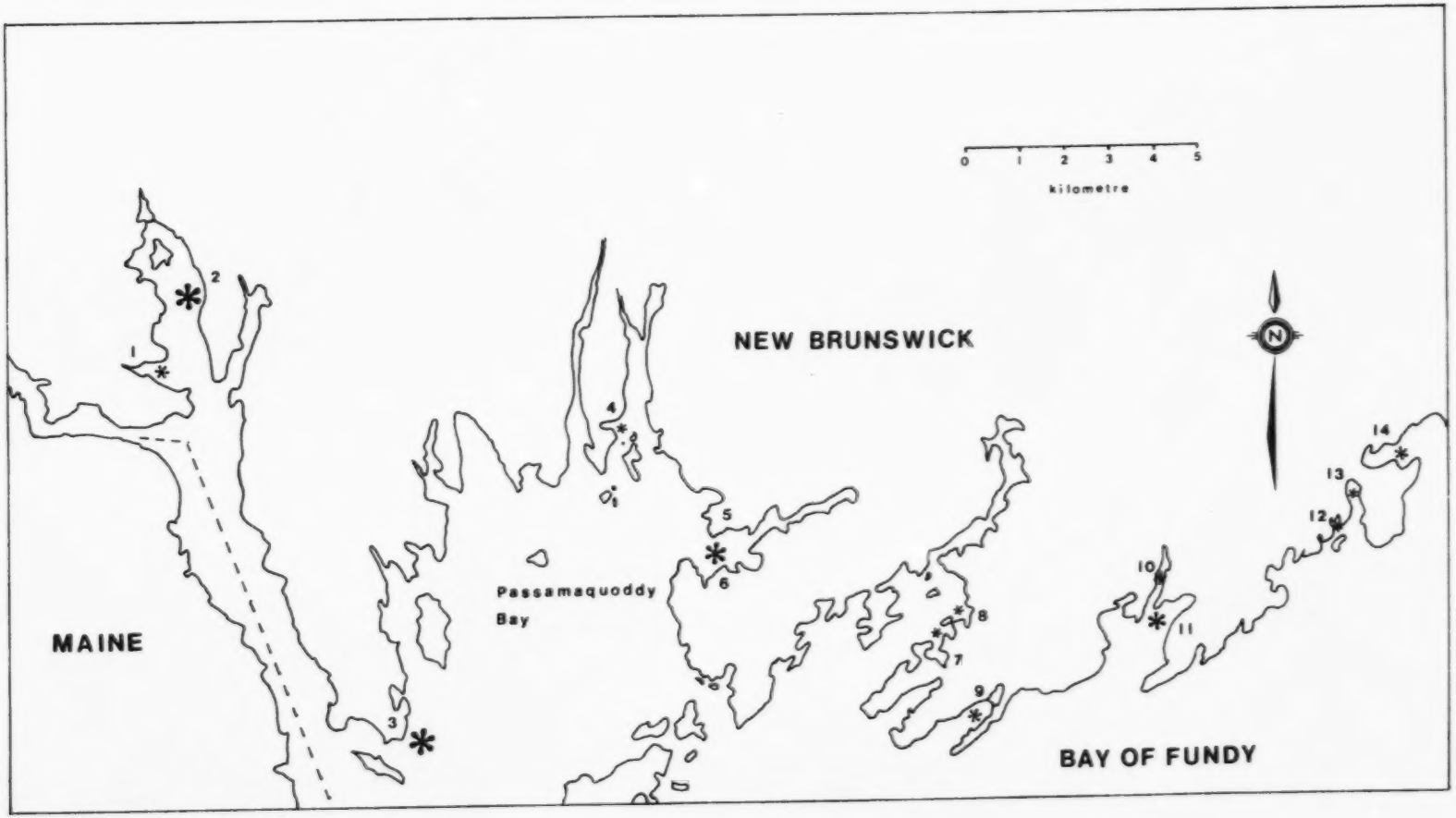

Figure 1. Location of closed areas surveyed in Charlotte County, New Brunswick: 1: Pagan Cove; 2: Oak Bay; 3: St. Andrews; 4: Boom's Cove; 5: Magaguadavic River, north shore; 6: Magaguadavic River, south shore; 7: Sturgeon Cove; 8: Cricket Flats; 9: Deadman Harbour; 10: Buckman's Creek; 11: Woodland; 12: Seeley Redhead; 13: Redhead Harbour; 14: Pocologan Harbour.

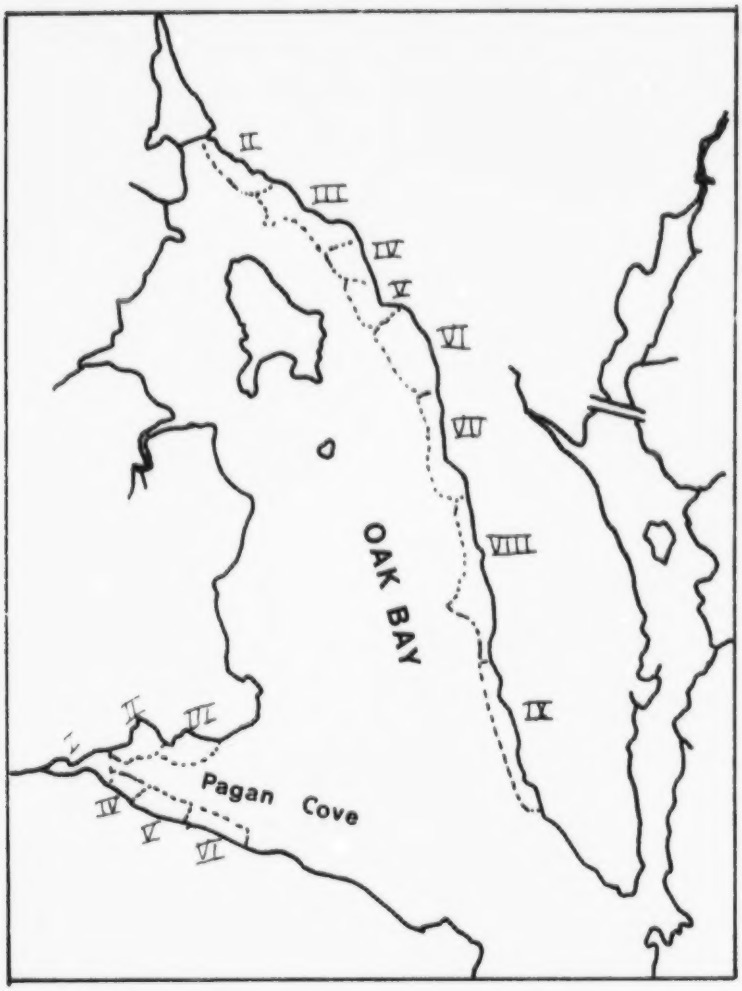

Figure 2. Sections investigated in Oak Bay and Pagan Cove. Scale: 1:50,000.

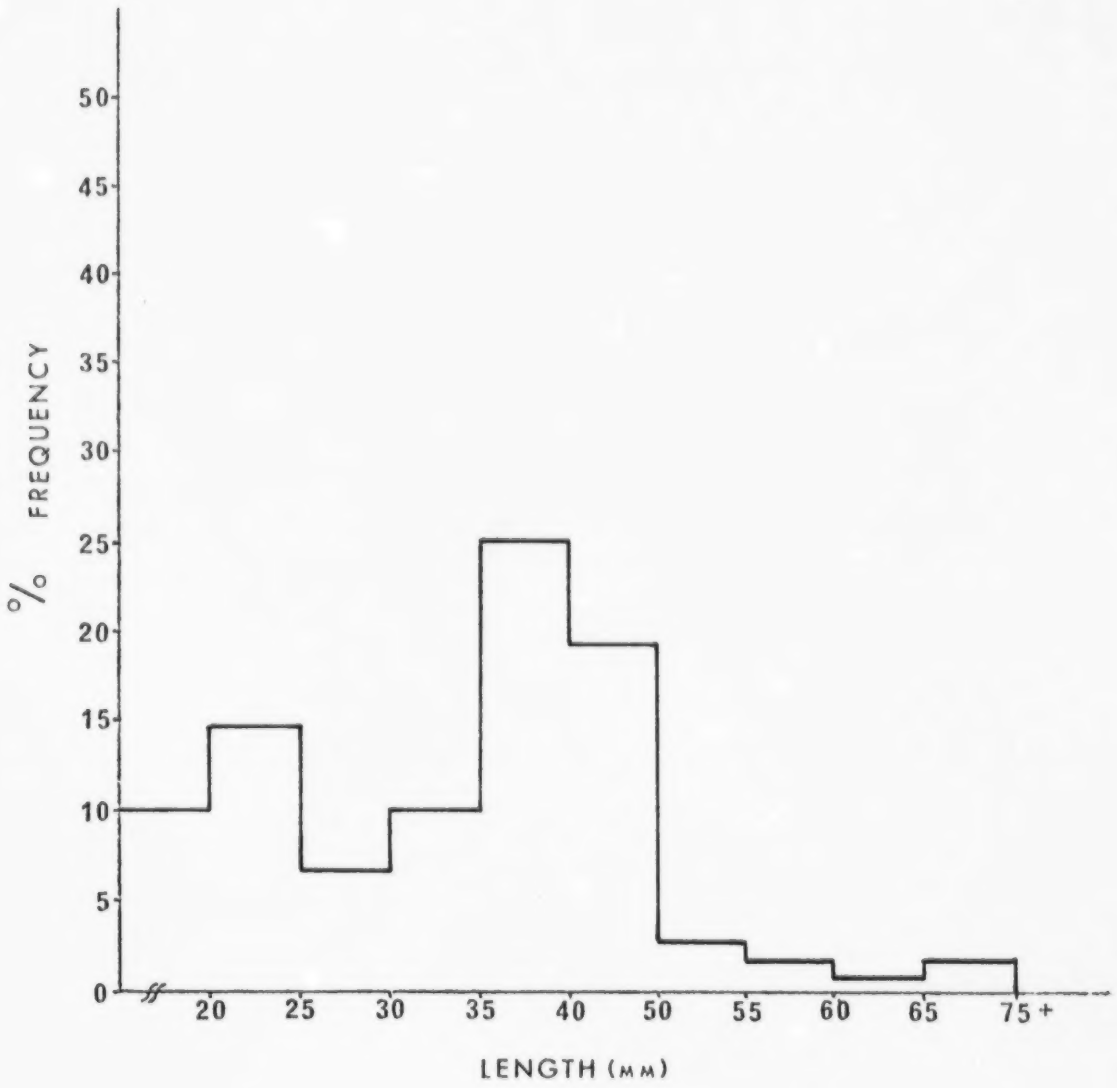

Figure 3. Size-frequency distribution, Oak Bay, Section II.

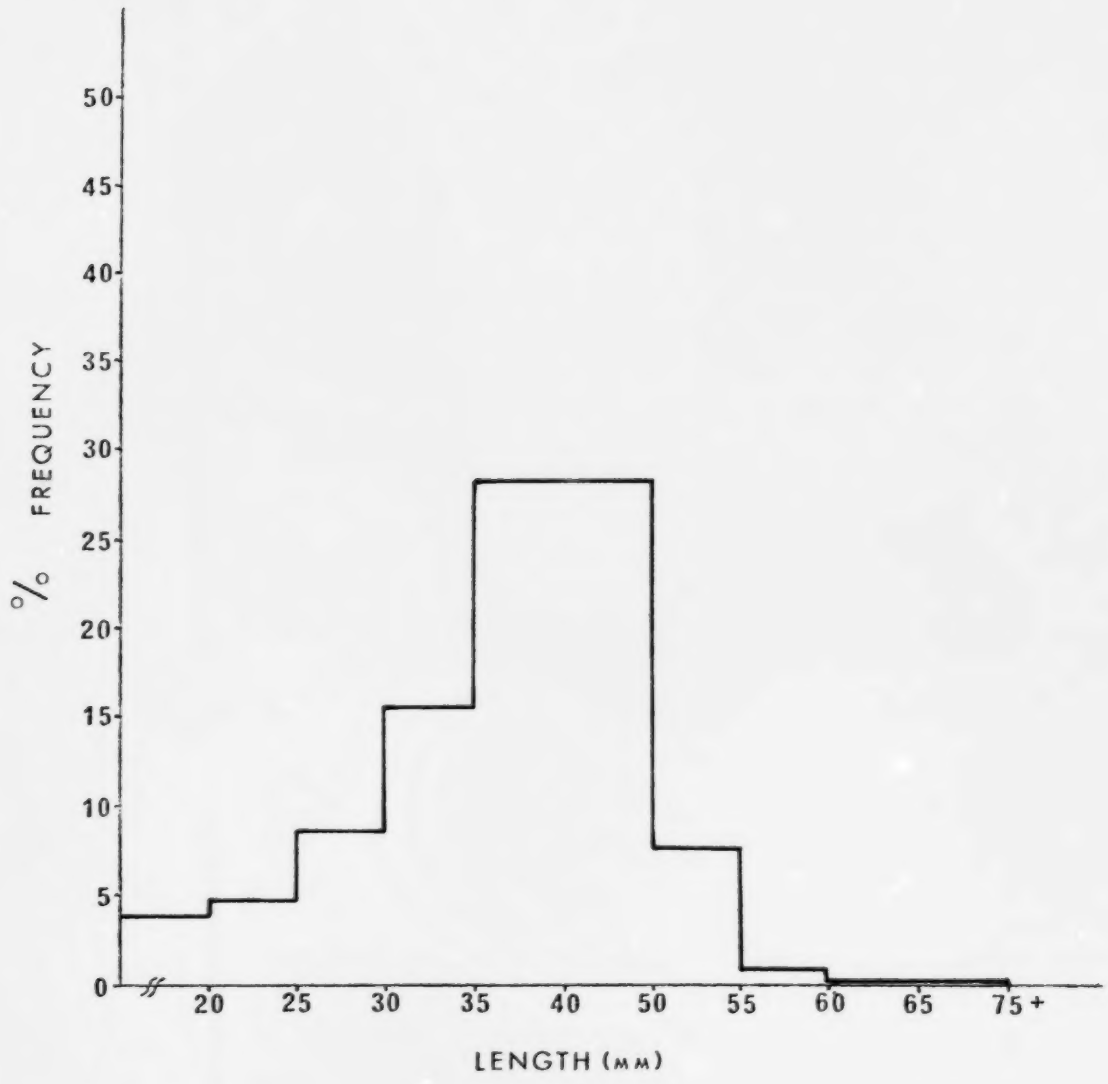

Figure 4. Size-frequency distribution, Oak Bay, Section III.

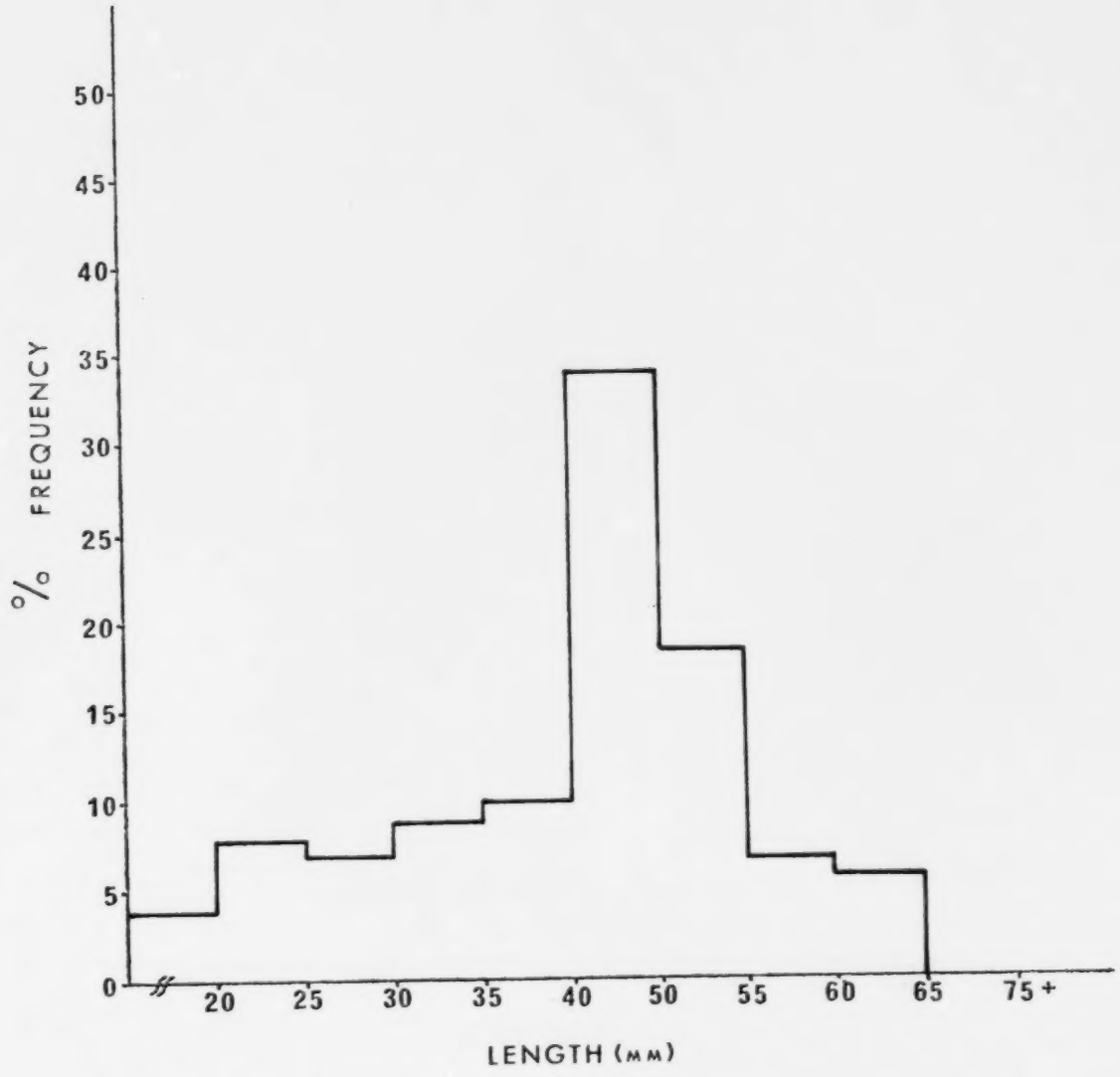

Figure 5. Size-frequency distribution, Oak Bay, Section IV.

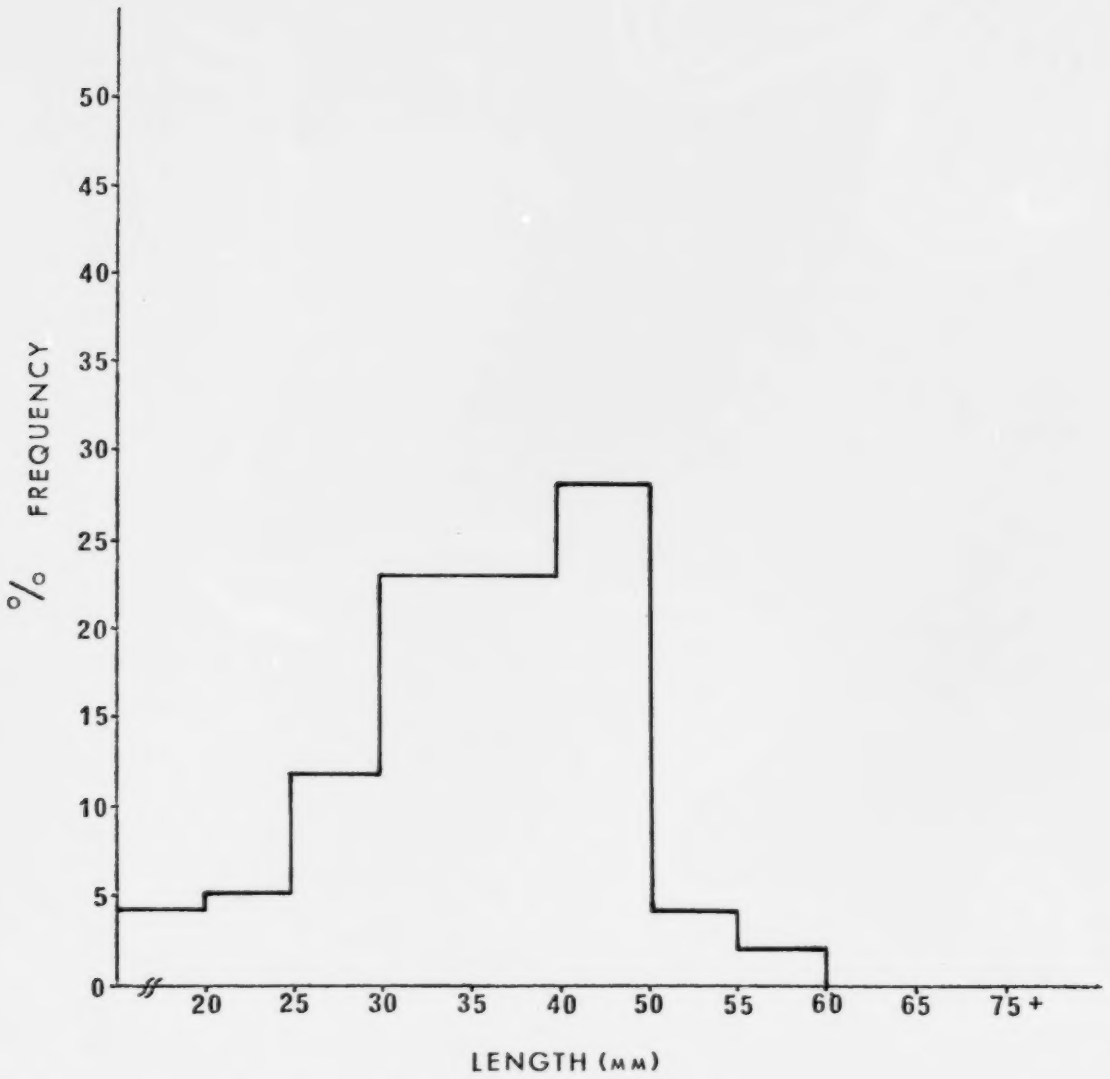

Figure 6. Size-frequency distribution, Oak Bay, Section V.

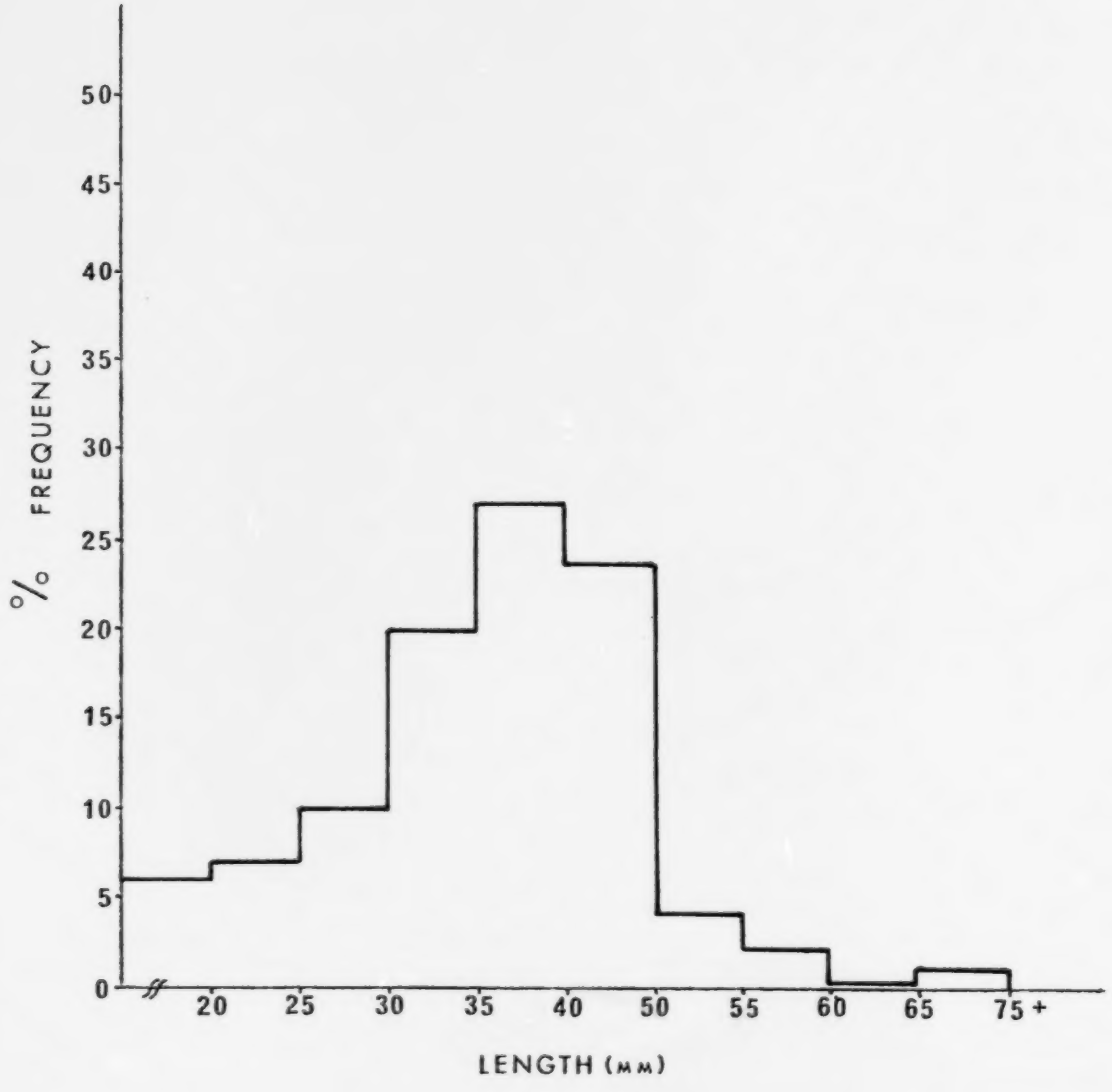

Figure 7. Size-frequency distribution, Oak Bay, Section VI.

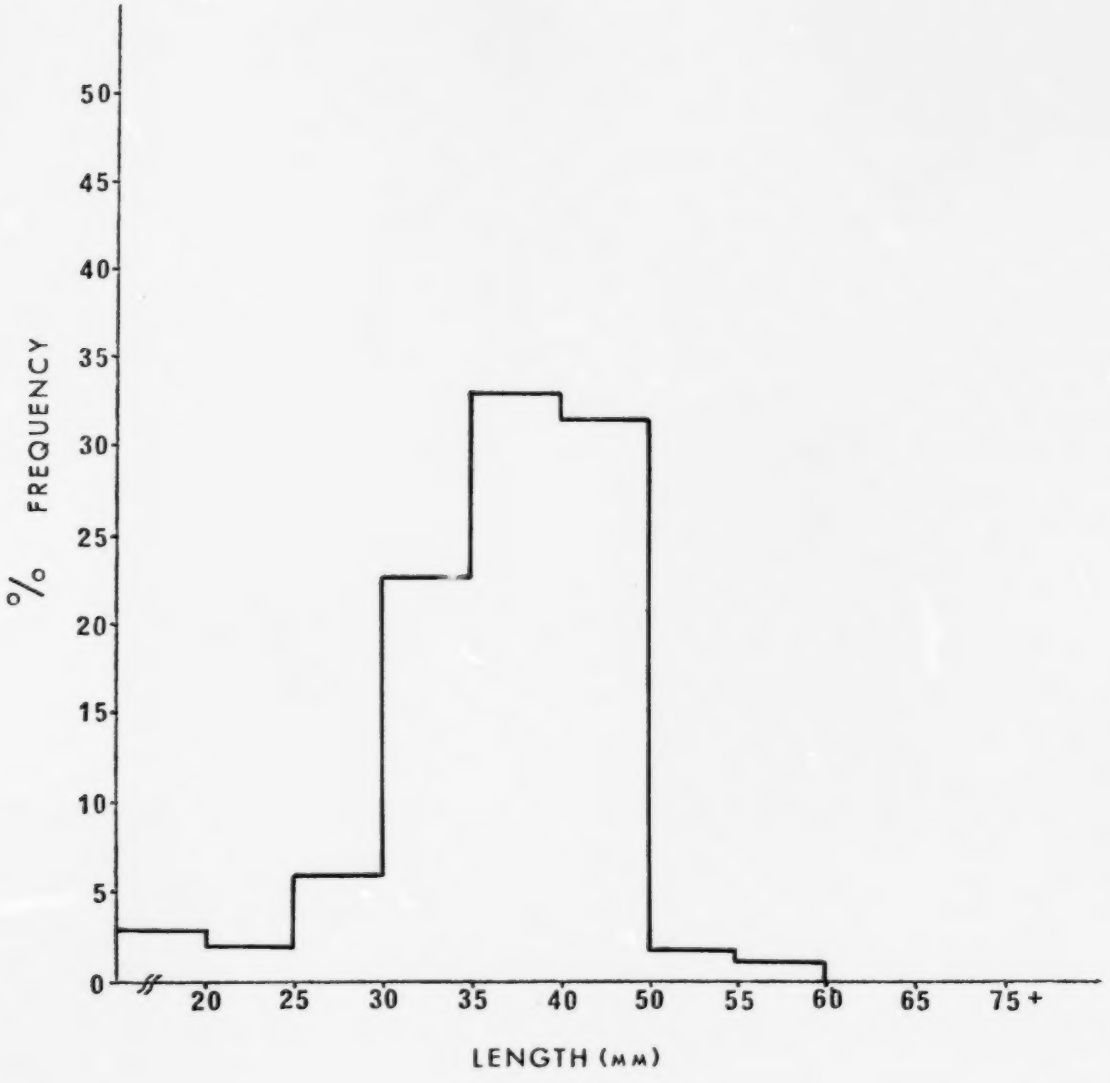

Figure 8. Size-frequency distribution, Oak Bay, Section VII.

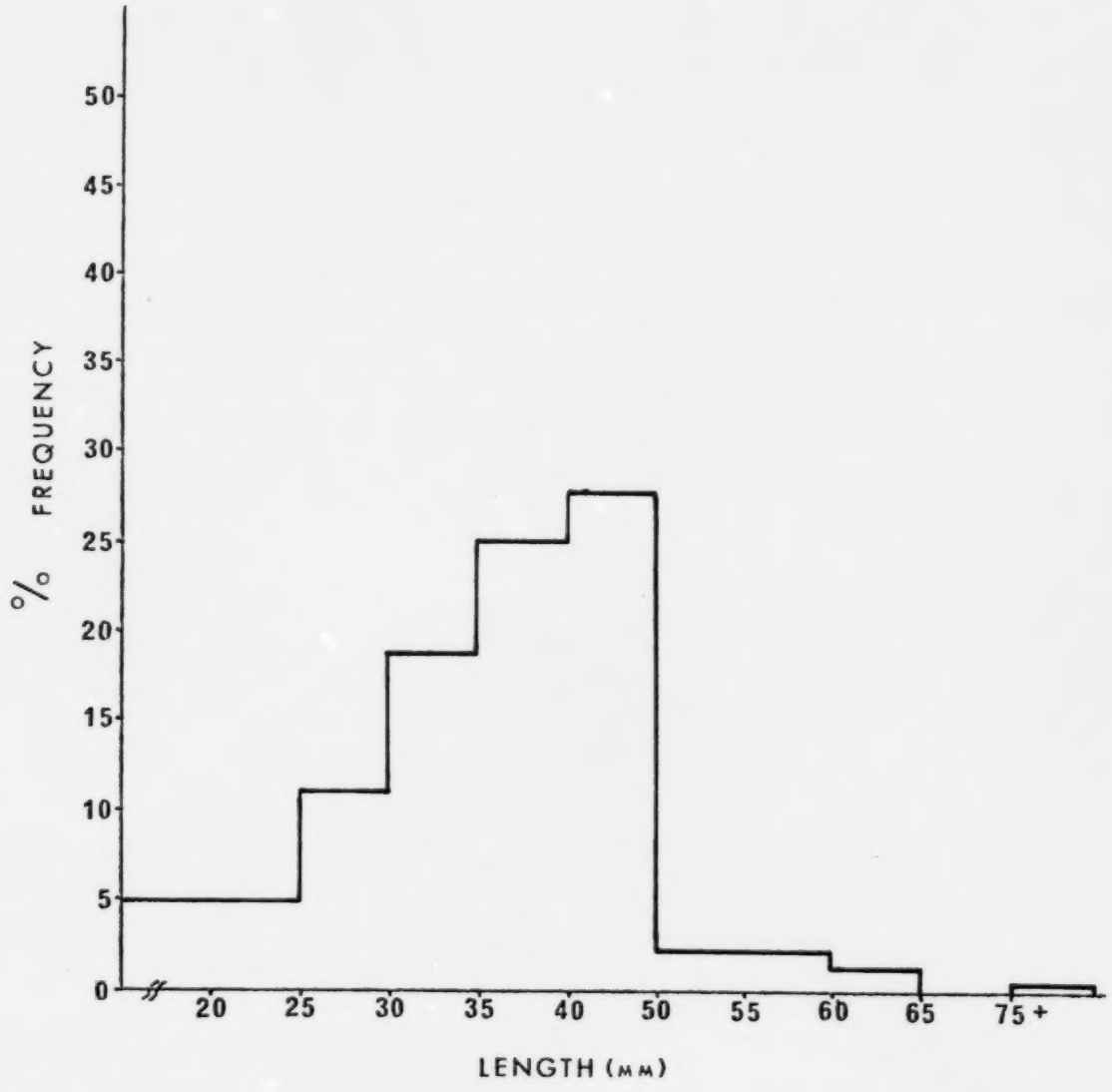

Figure 9. Size-frequency distribution, Oak Bay, Section VIII.

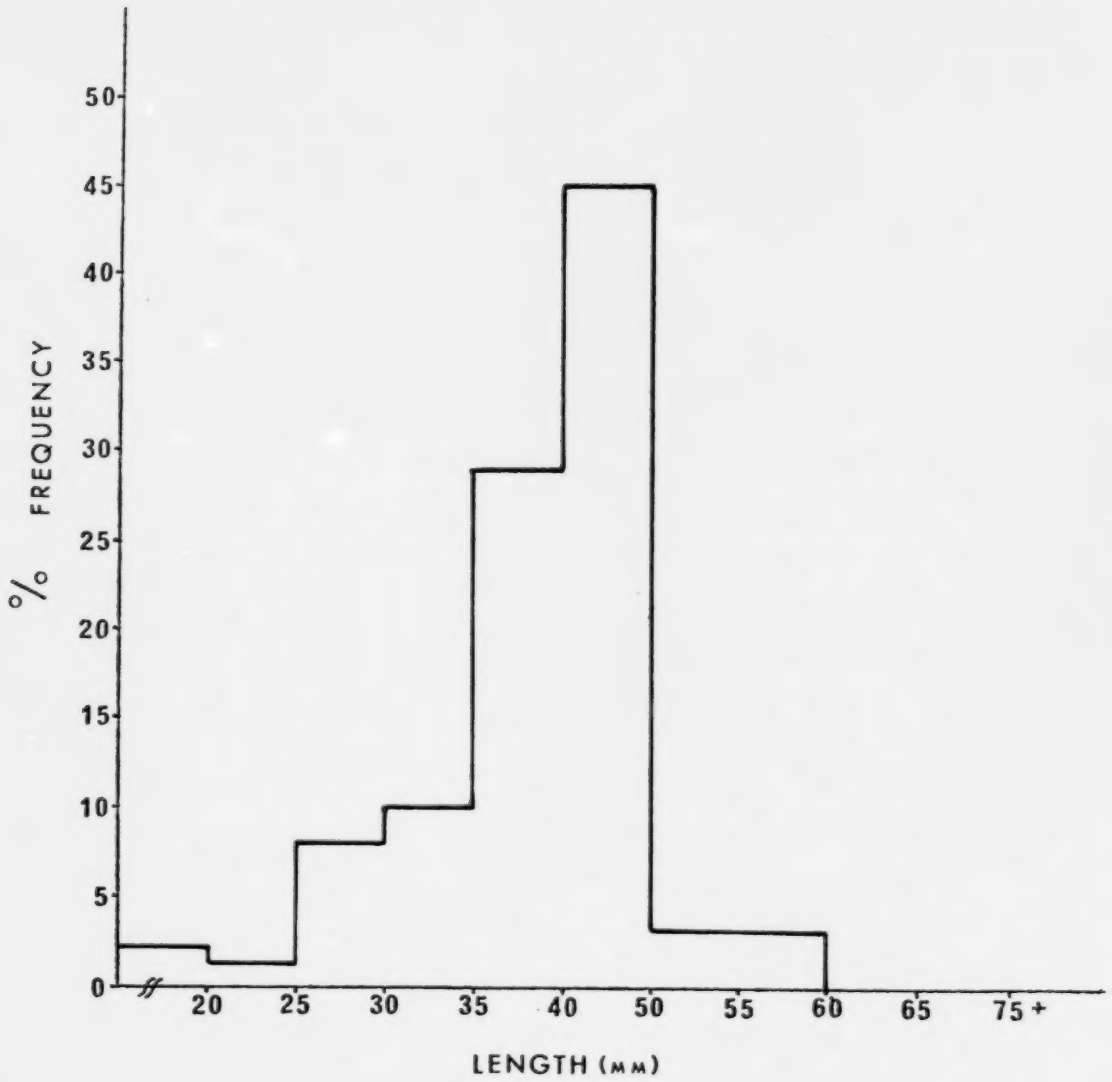

Figure 10. Size-frequency distribution, Oak Bay, Section IX.

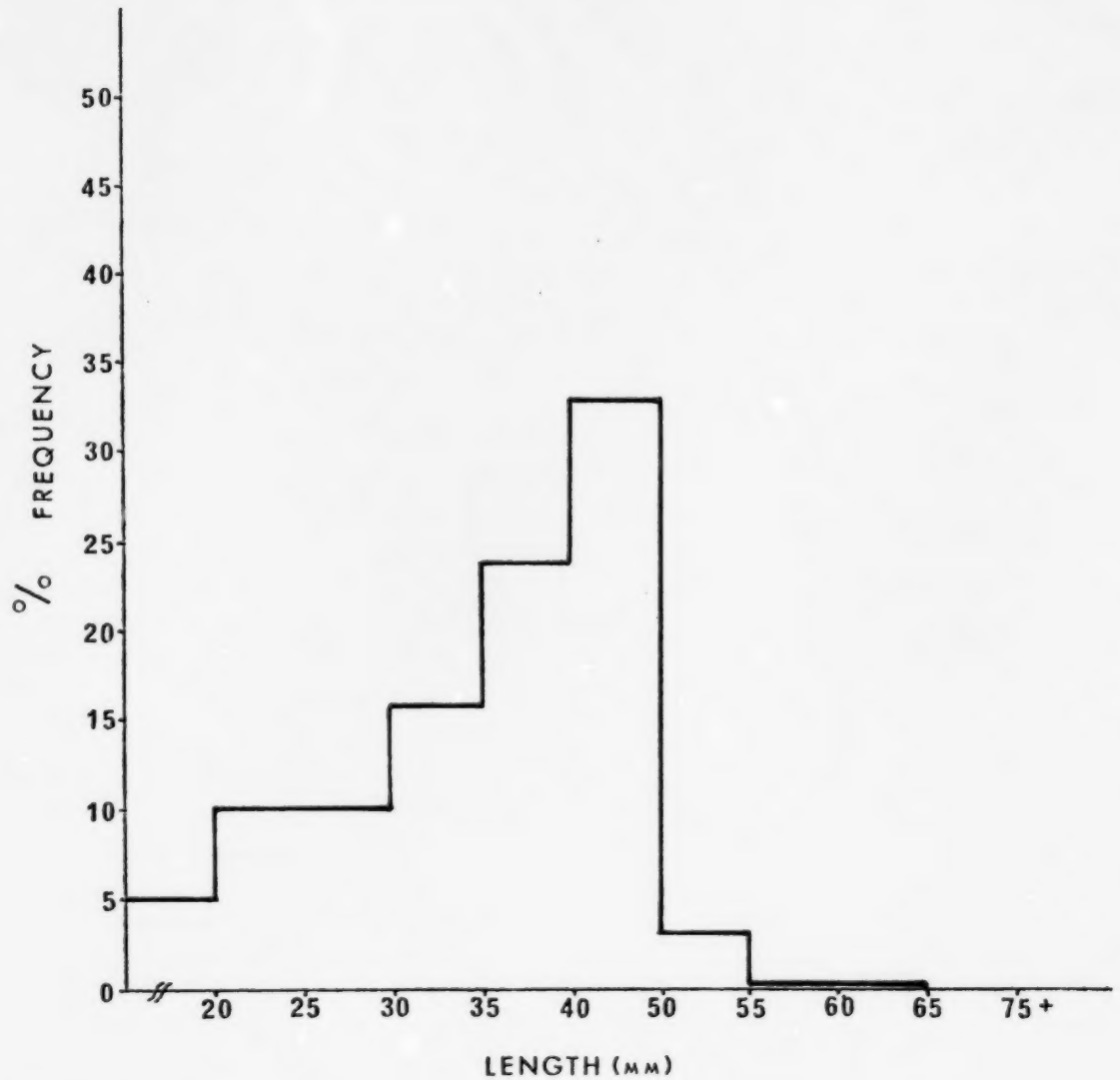

Figure 11. Size-frequency distribution, Pagan Cove, Section I.

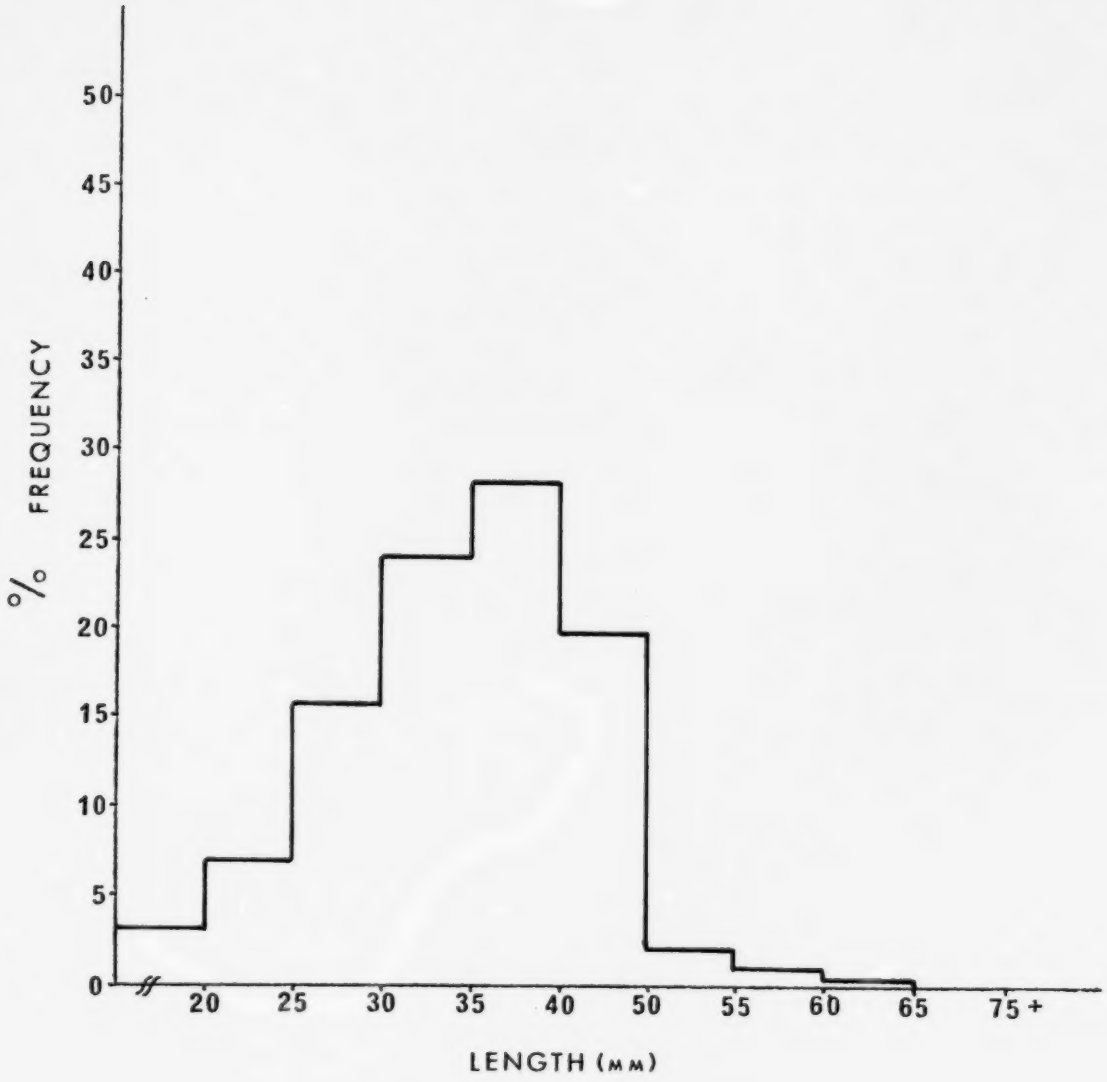

Figure 12. Size-frequency distribution, Pagan Cove, Section II.

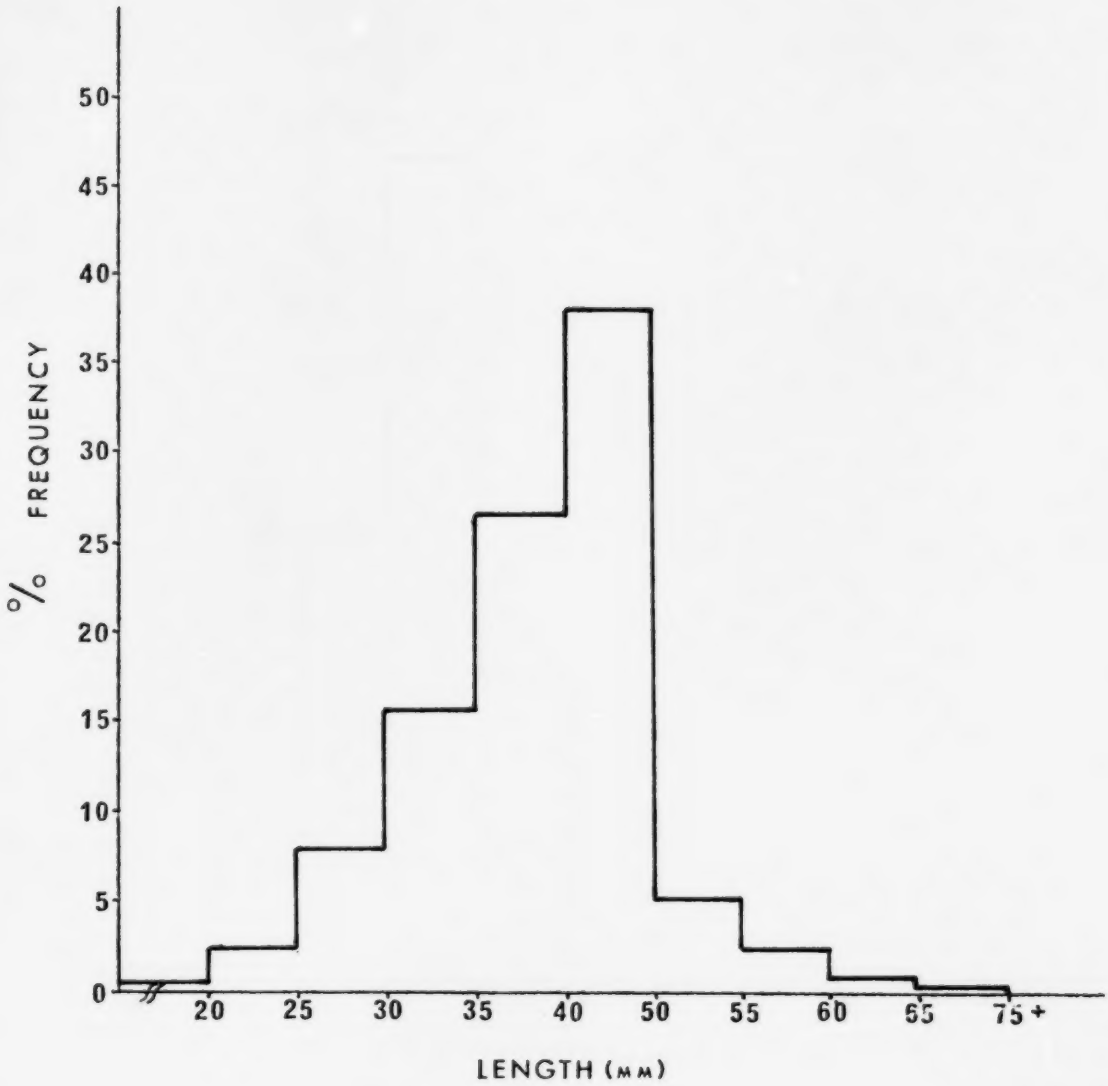

Figure 13. Size-frequency distribution, Pagan Cove, Section III.

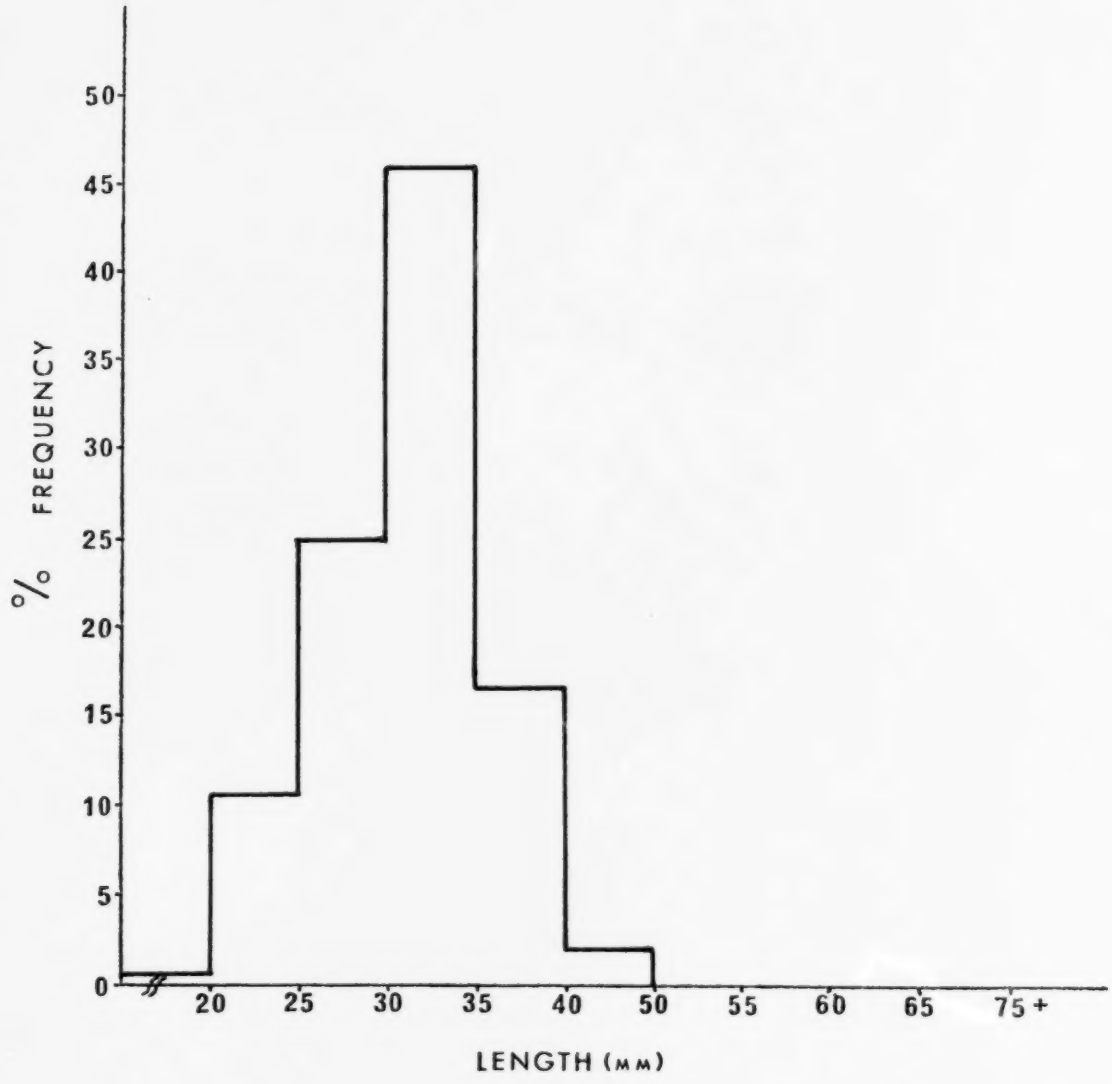

Figure 14. Size-frequency distribution, Pagan Cove, Section IV.

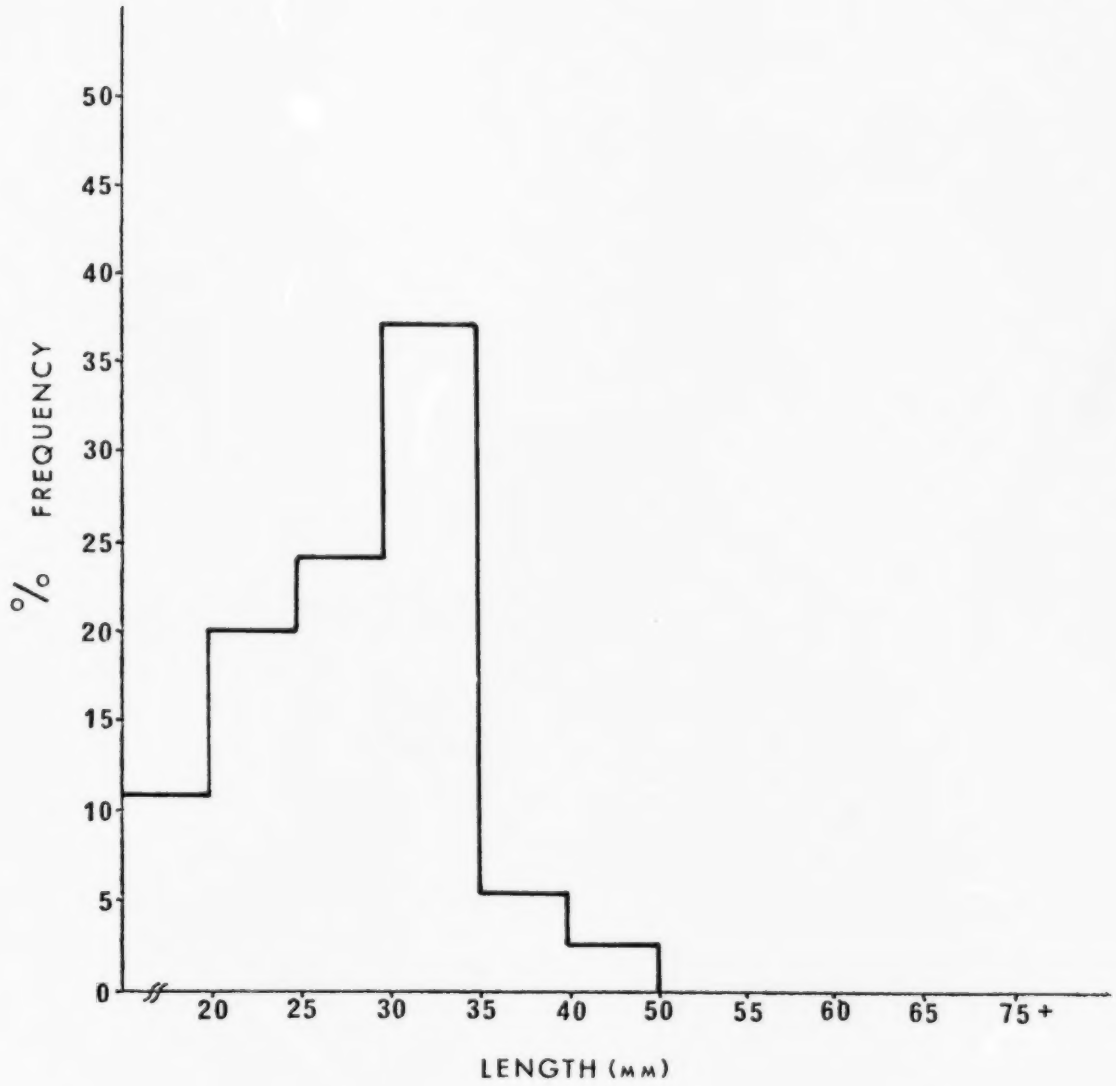

Figure 15. Size-frequency distribution, Pagan Cove, Section V.

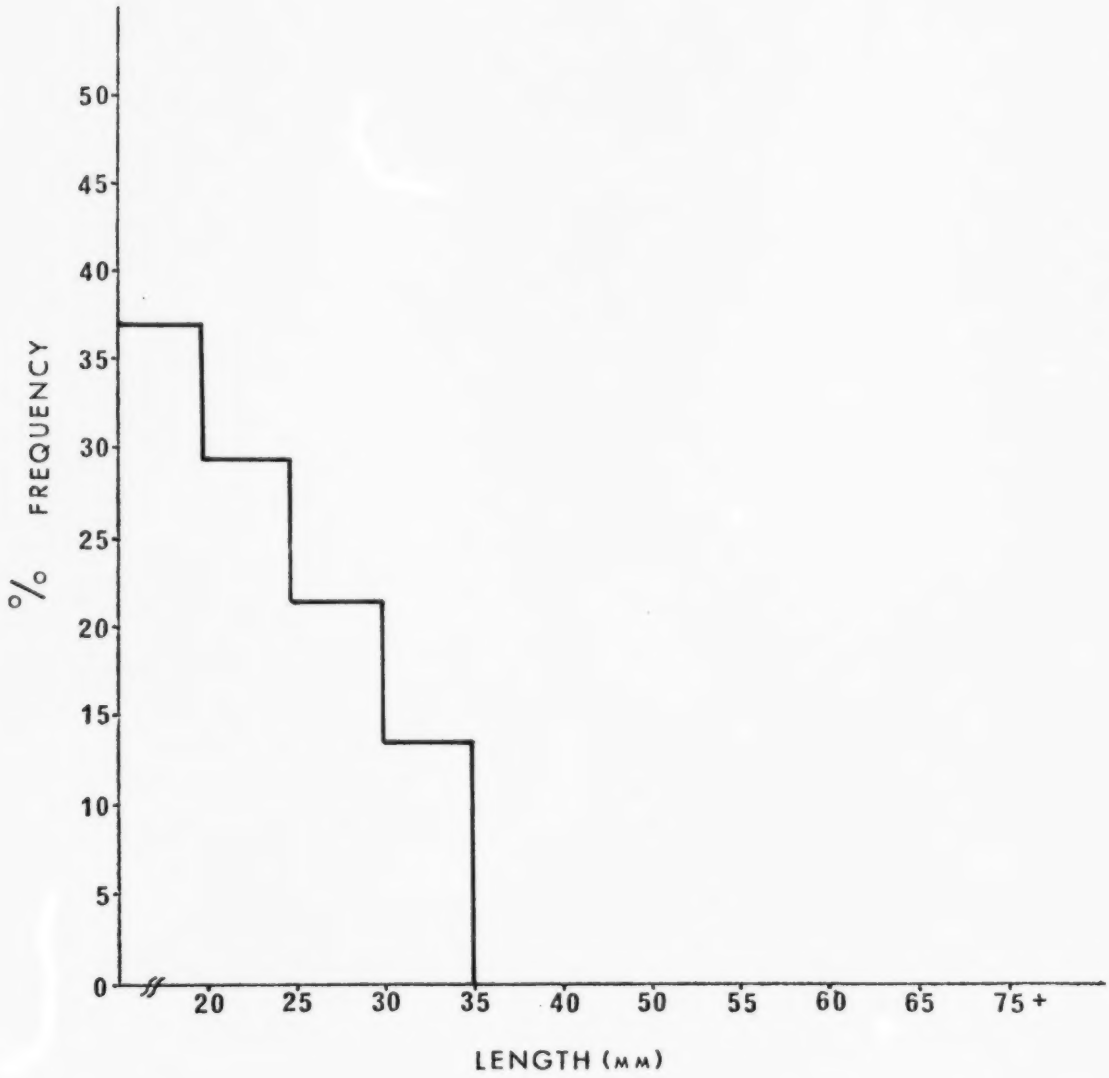

Figure 16. Size-frequency distribution, Pagan Cove, Section VI.

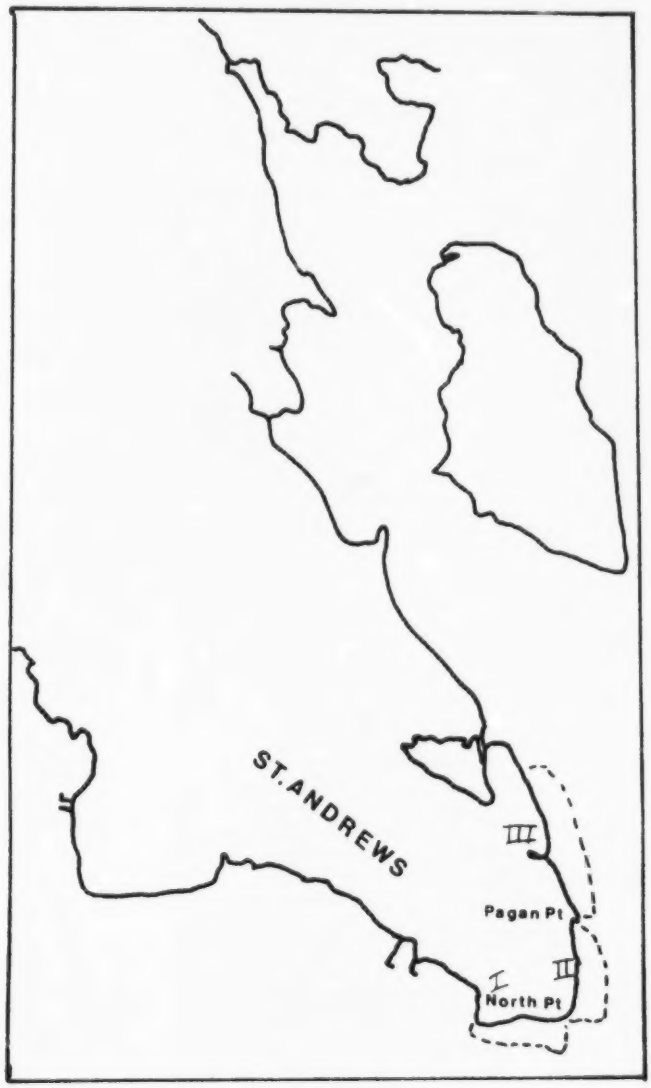

Figure 17. Size-frequency distribution, Oak Bay, Section VI.

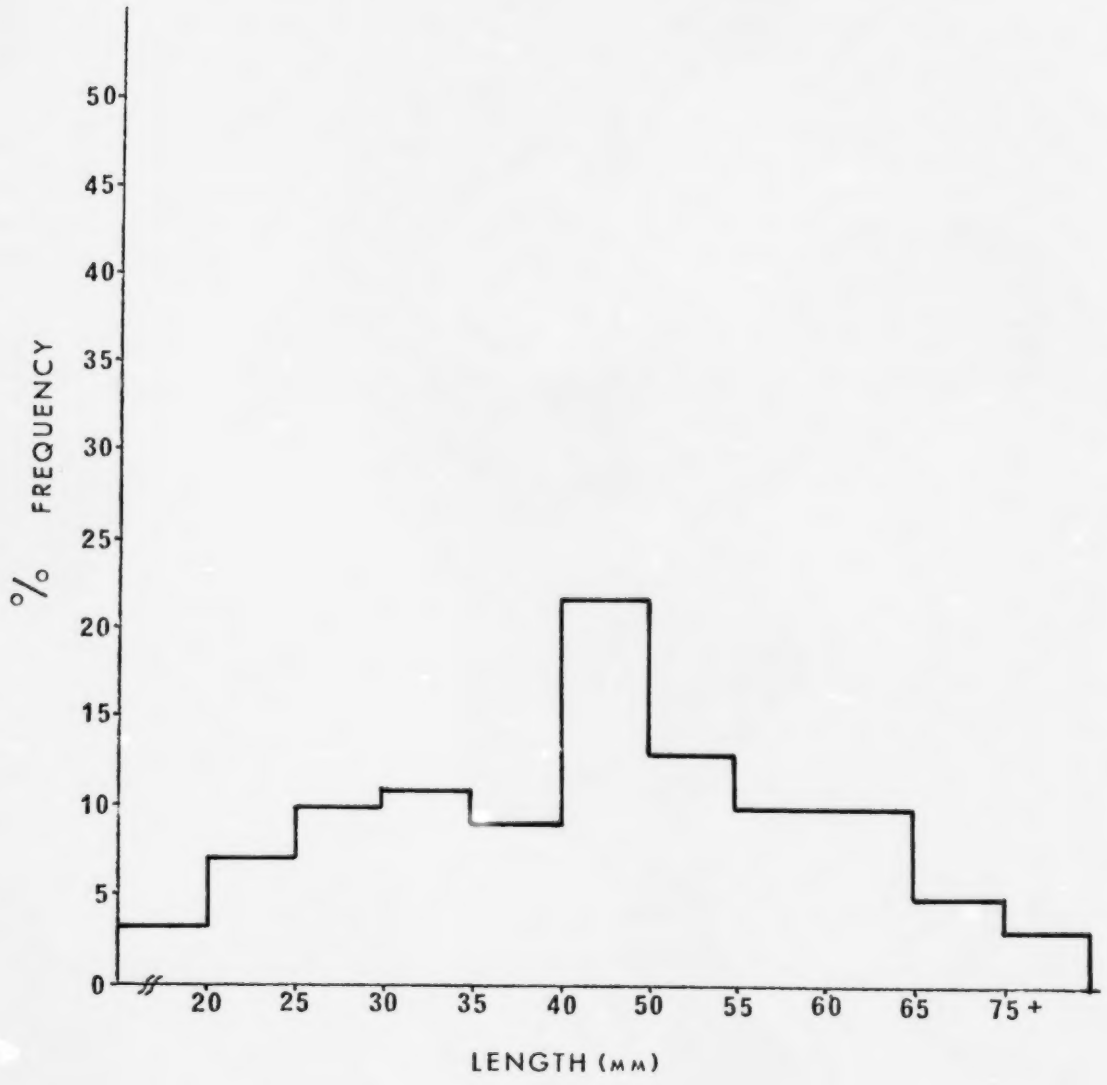

Figure 18. Size-frequency distribution, St. Andrews, Section I.

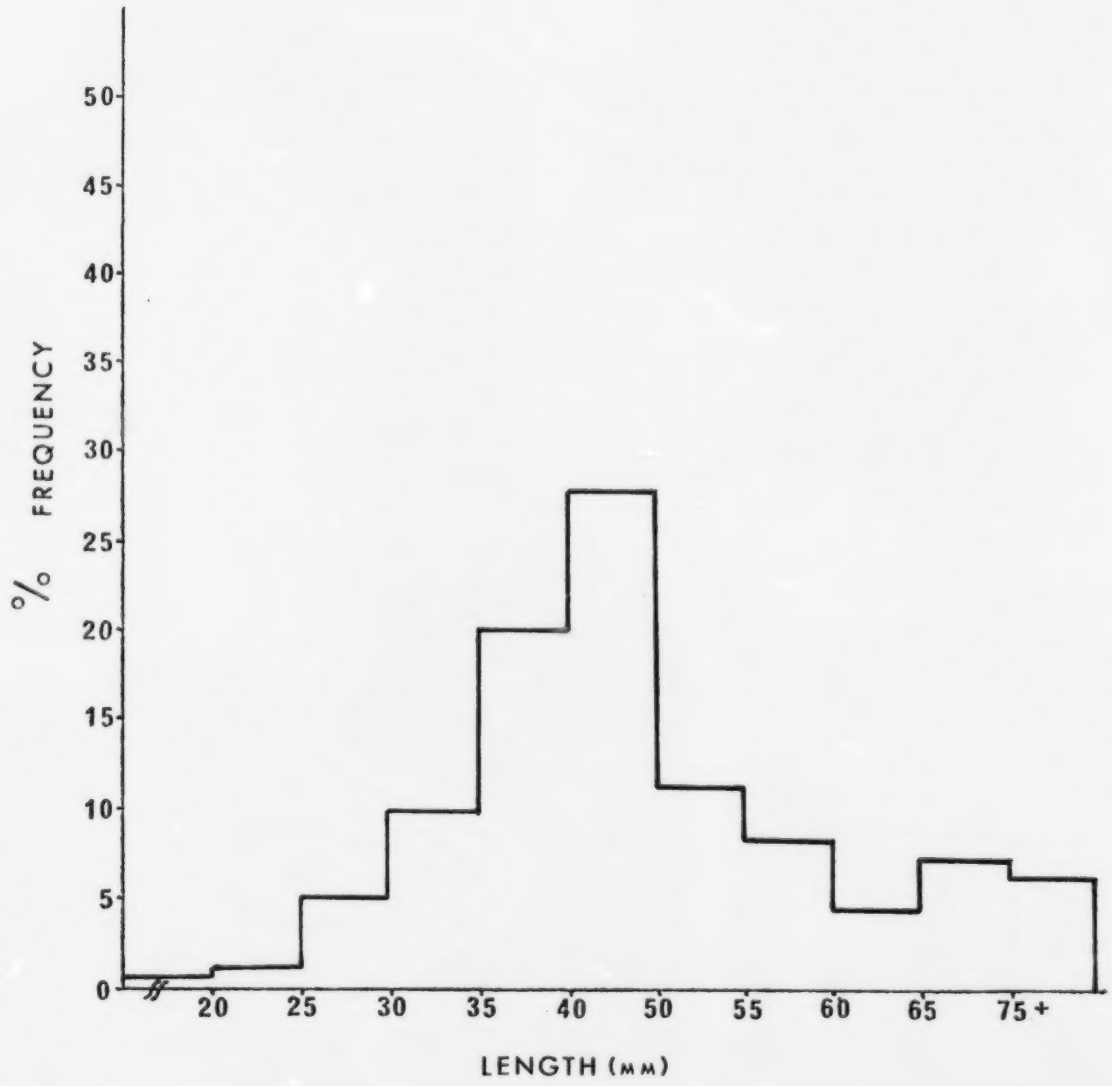

Figure 19. Size-frequency distribution, St. Andrews, Section II.

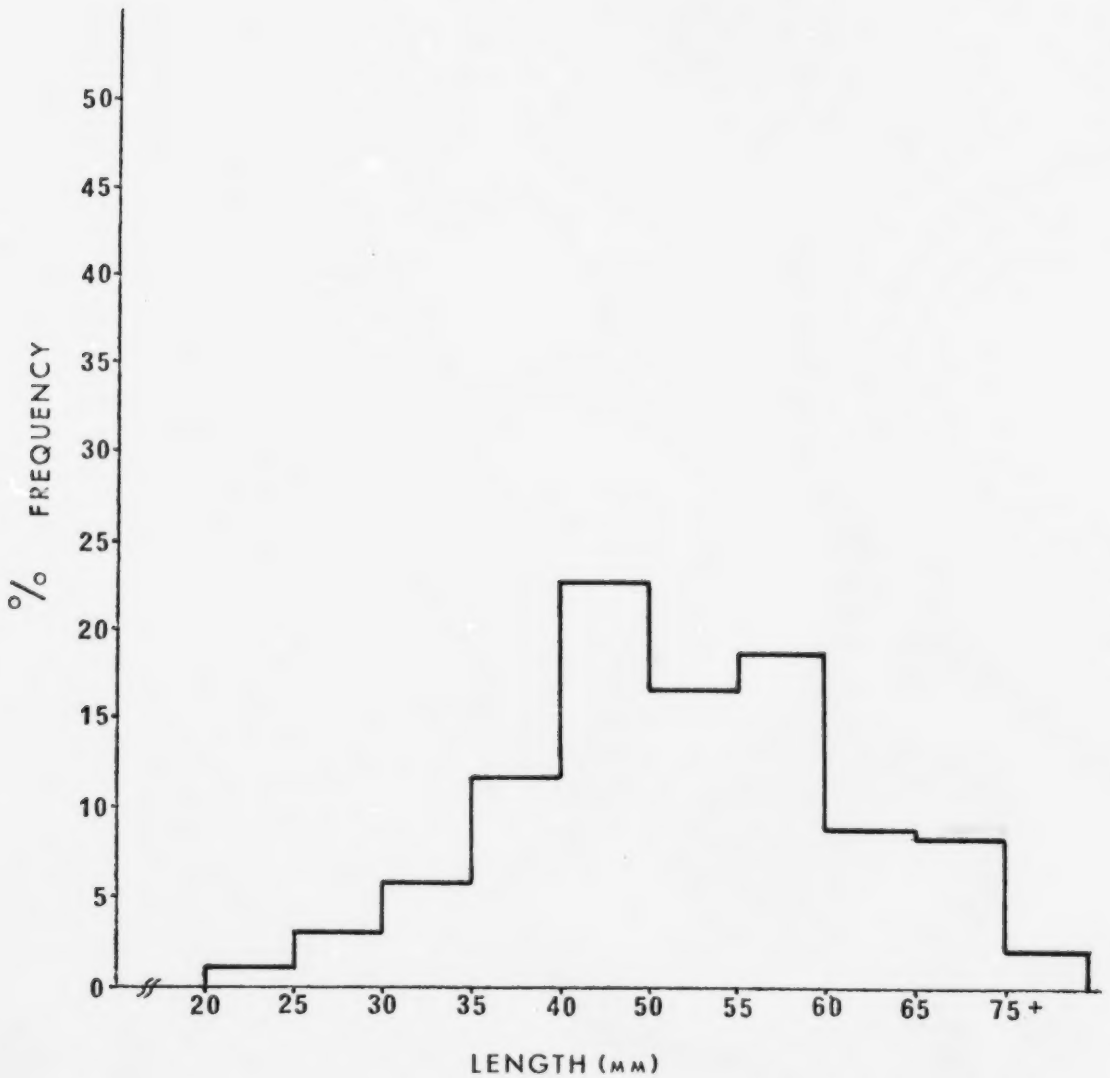

Figure 20. Size-frequency distribution, St. Andrews, Section III.

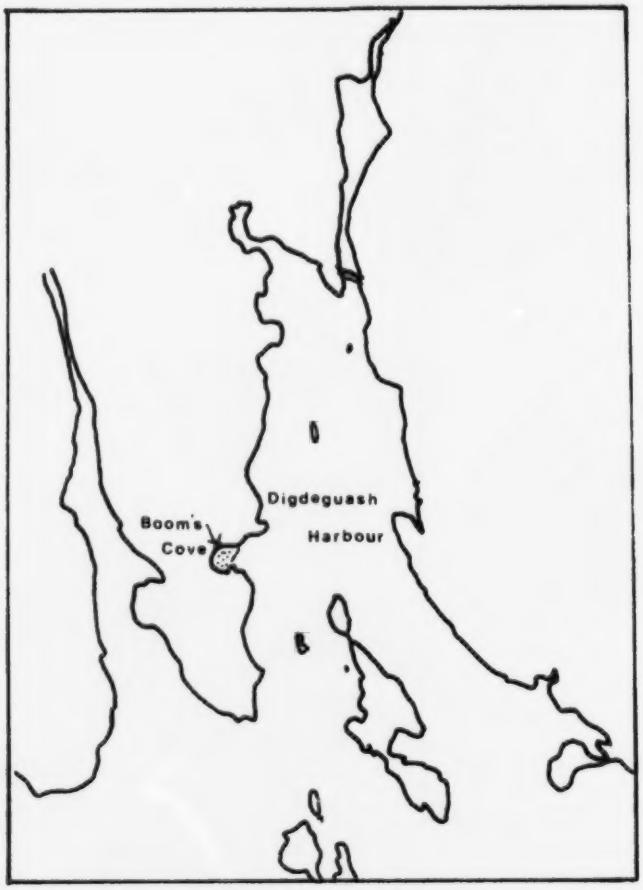

Figure 21. Boom's Cove on the western shore of Digdeguash Harbour.
Scale 1:50,000.

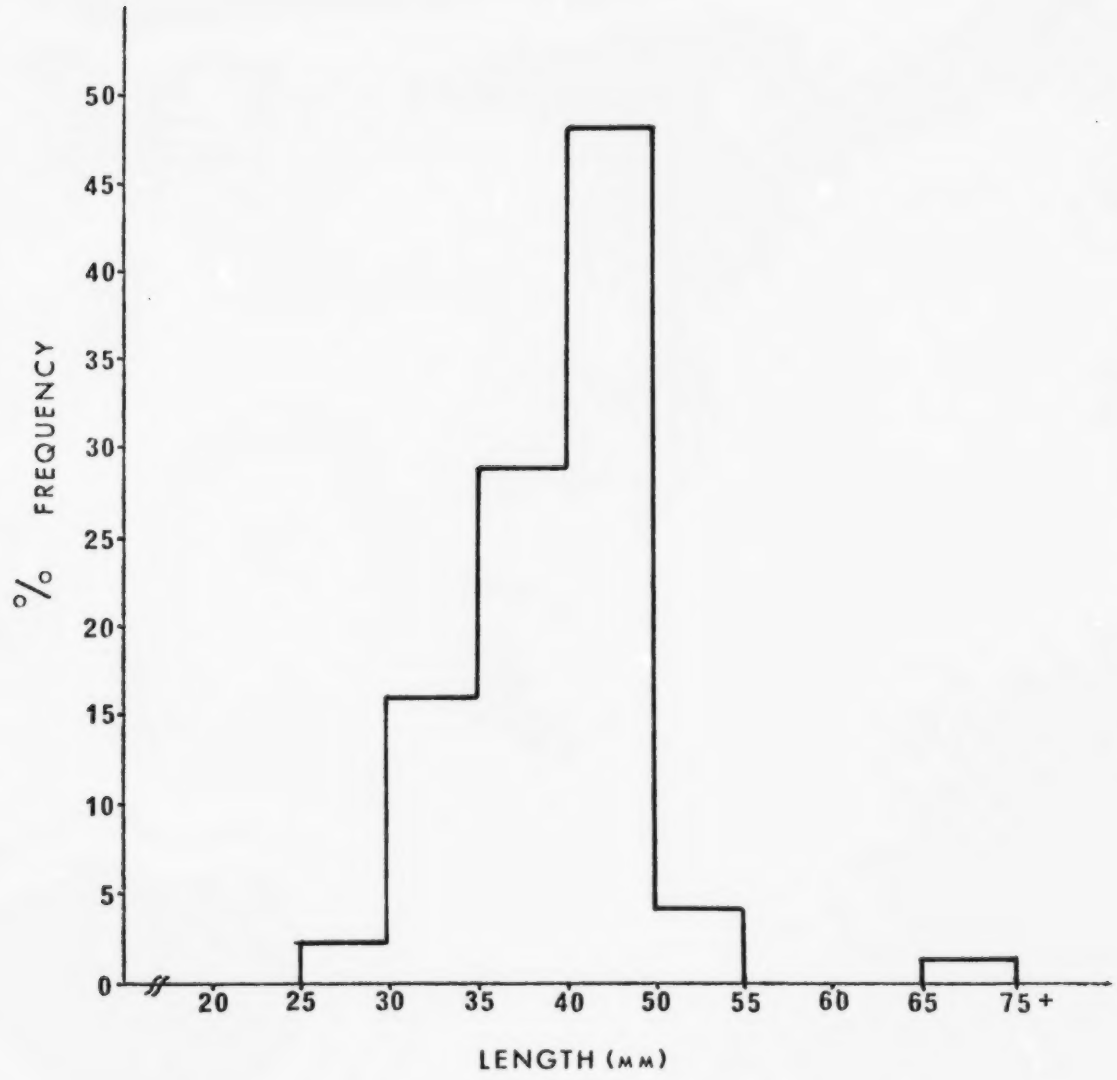

Figure 22. Size-frequency distribution, Boom's Cove.

Figure 23. Location of sections surveyed on both shores of Magaguadavic River. Scale 1:50,000.

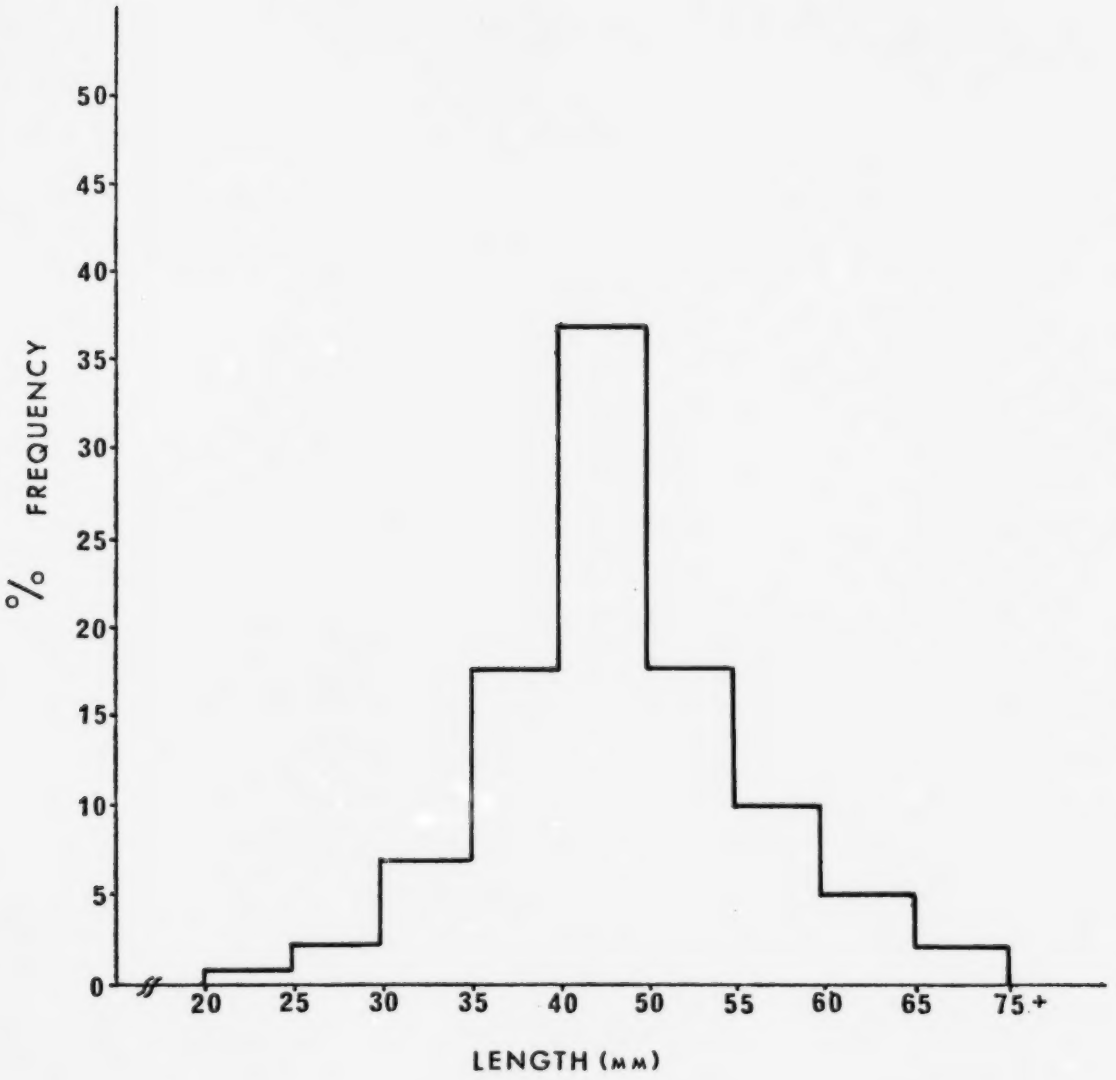

Figure 24. Size-frequency distribution, Magaguadavic River North, Section I.

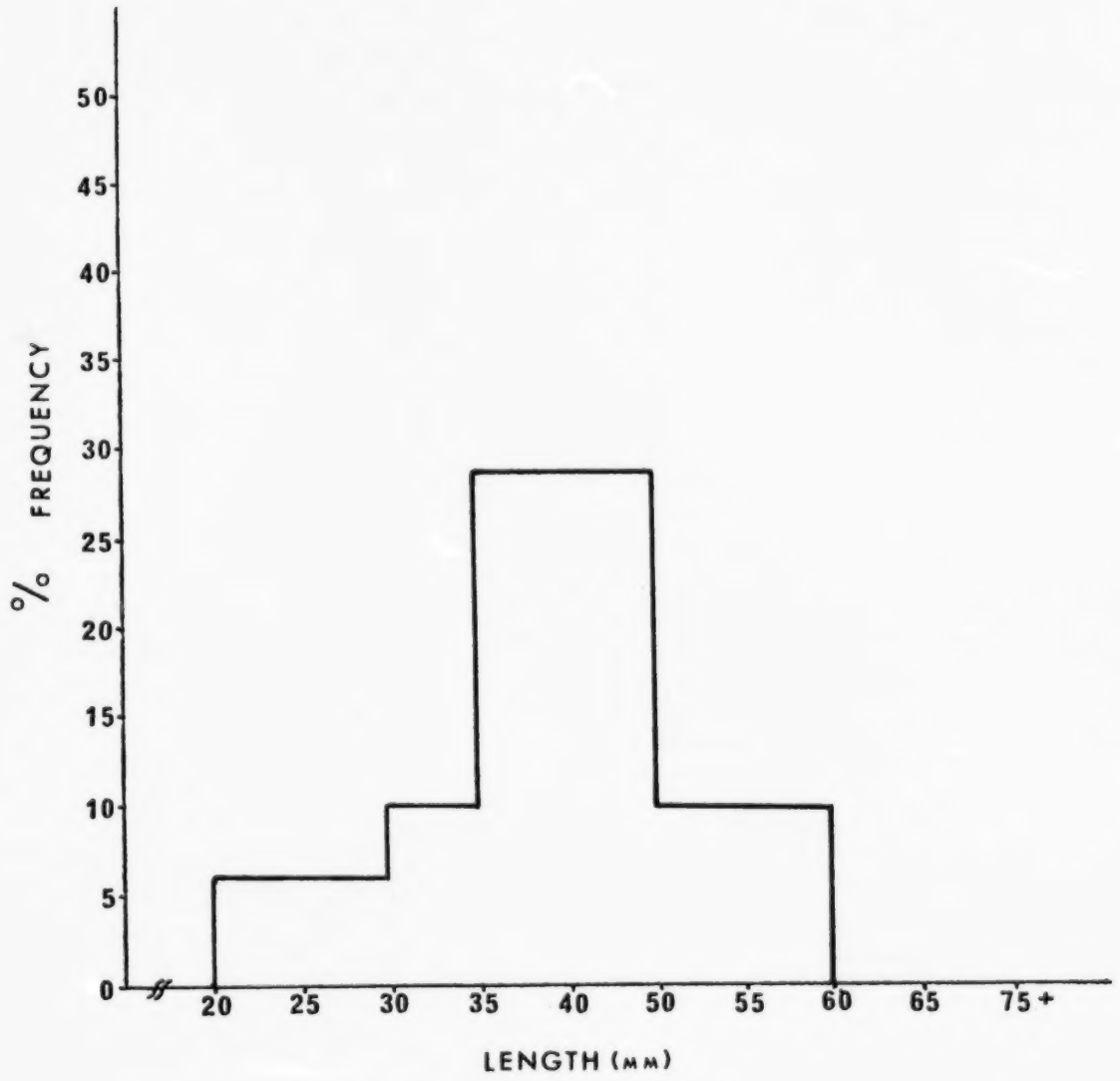

Figure 25. Size-frequency distribution, Magaguadavic River North, Section II.

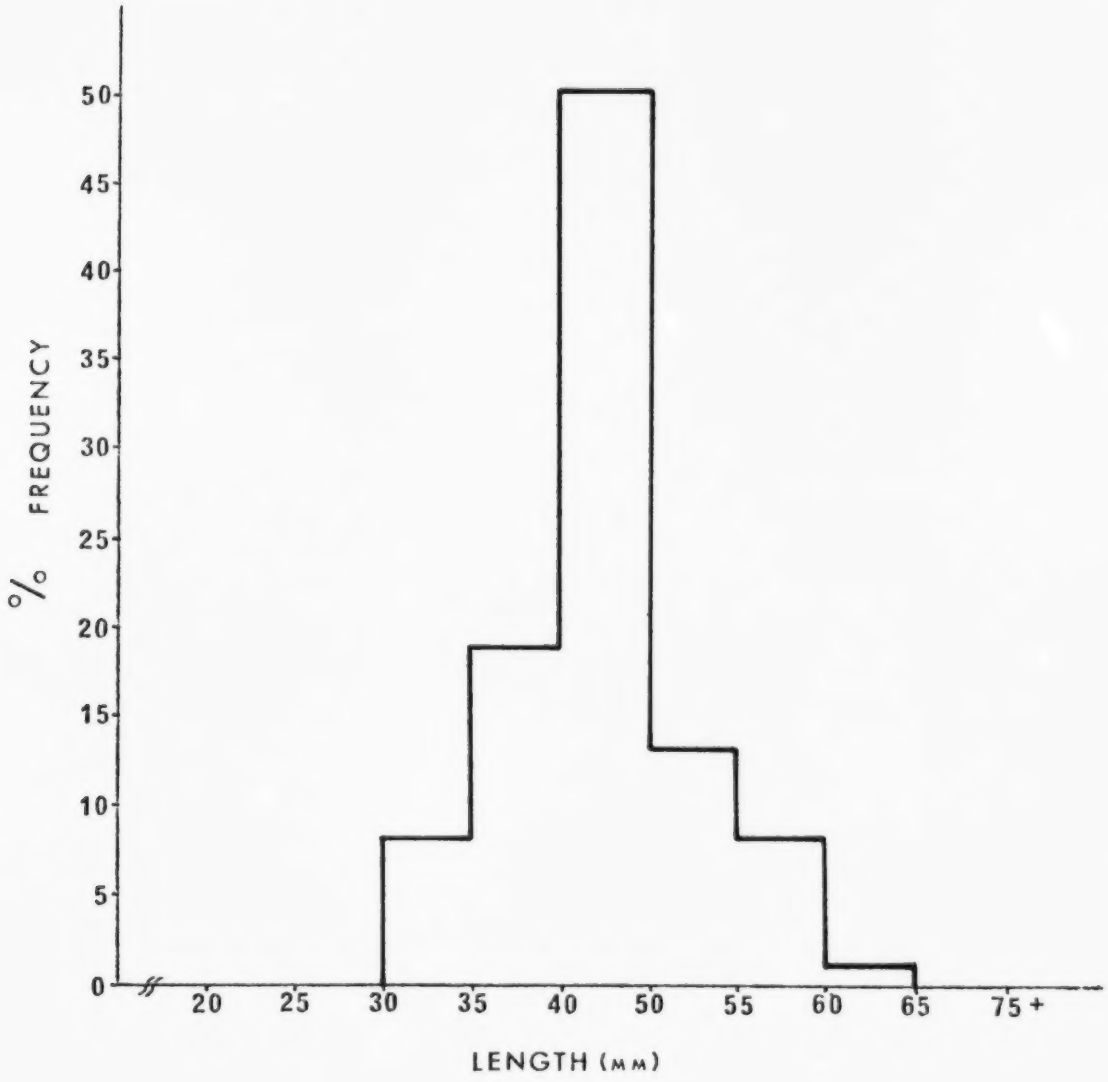

Figure 26. Size-frequency distribution, Magaguadavic River North, Section III.

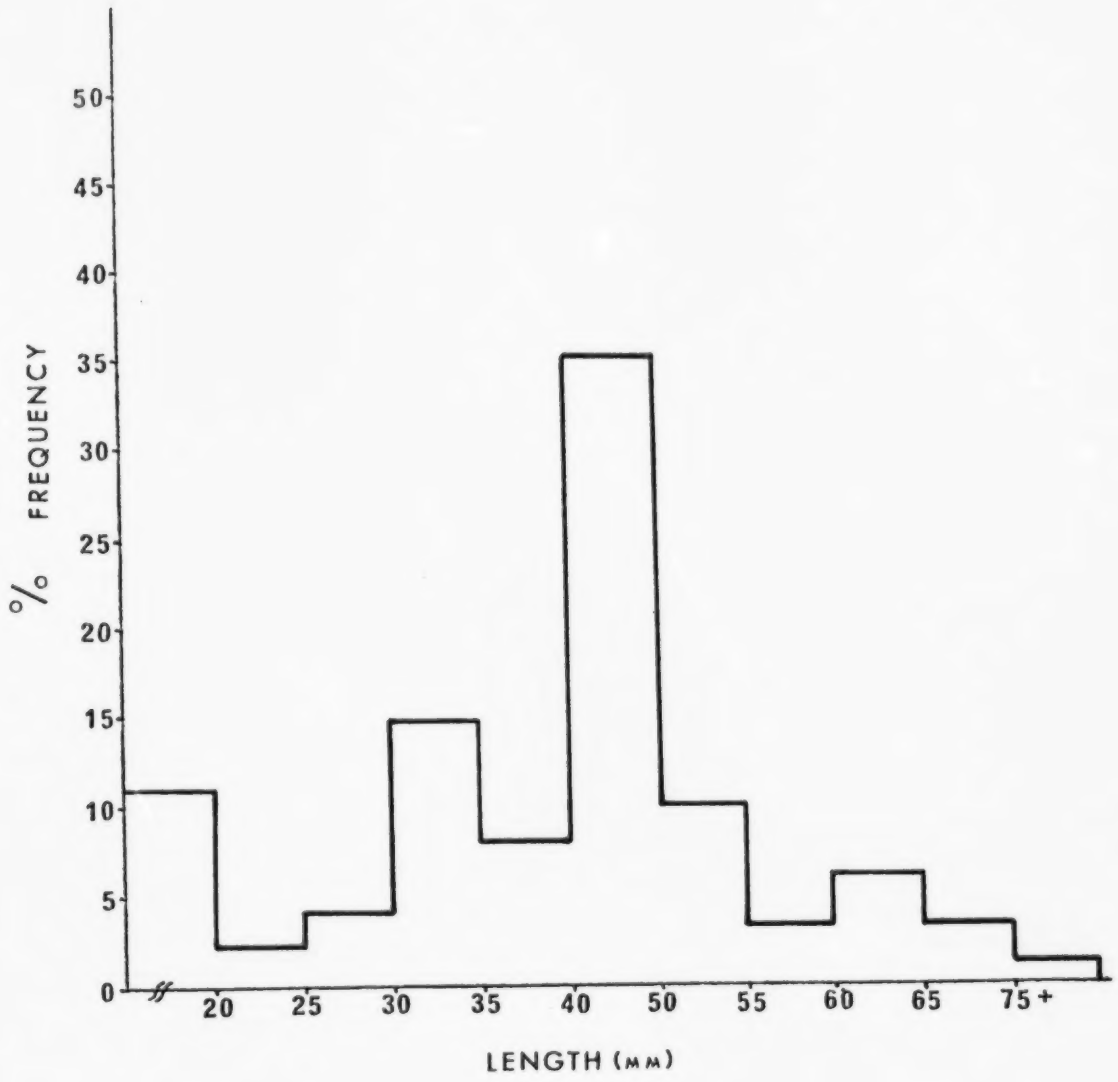

Figure 27. Size-frequency distribution, Magaguadavic River North, Section IV.

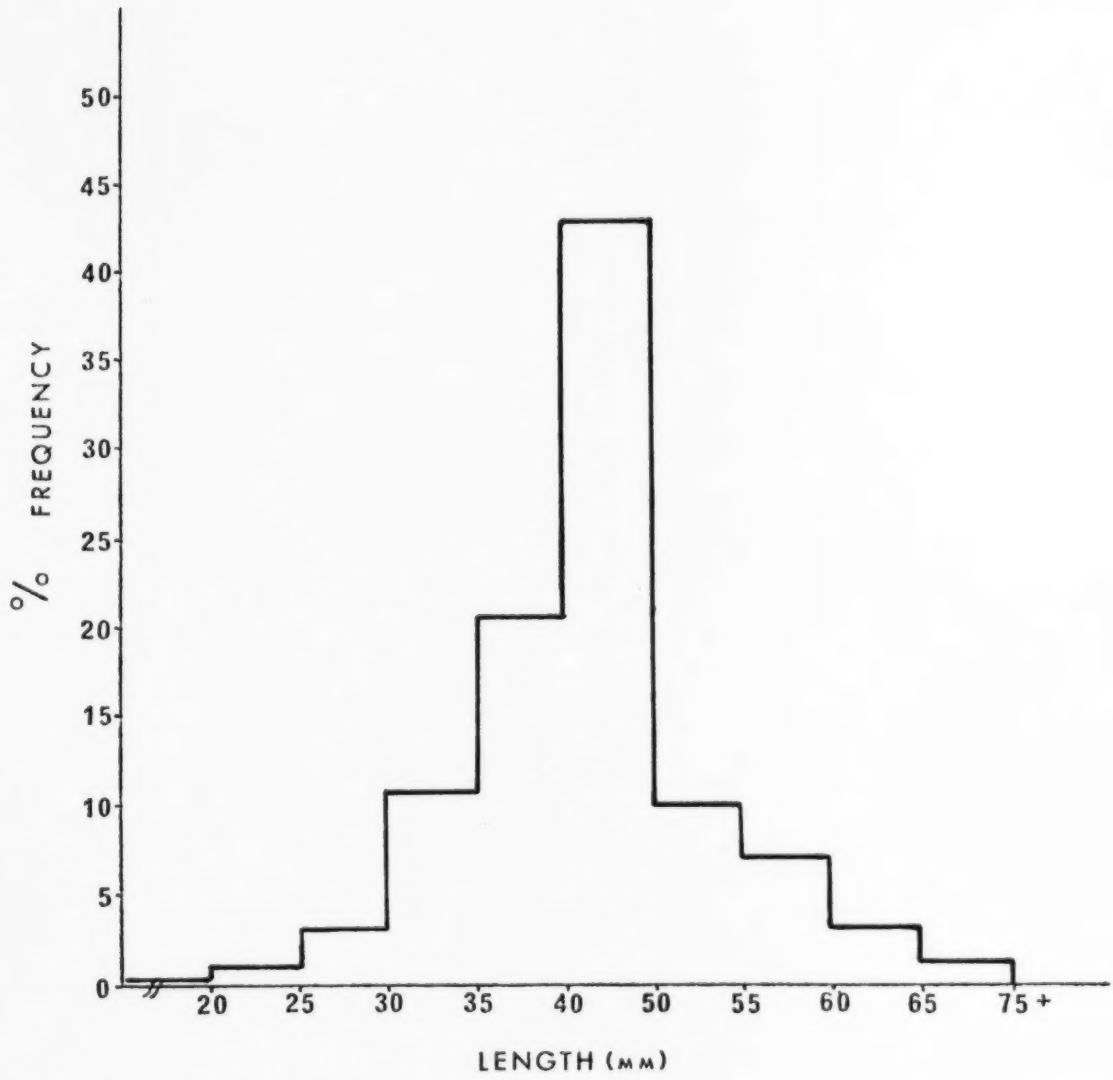

Figure 28. Size-frequency distribution, Magaguadavic River South, Section I.

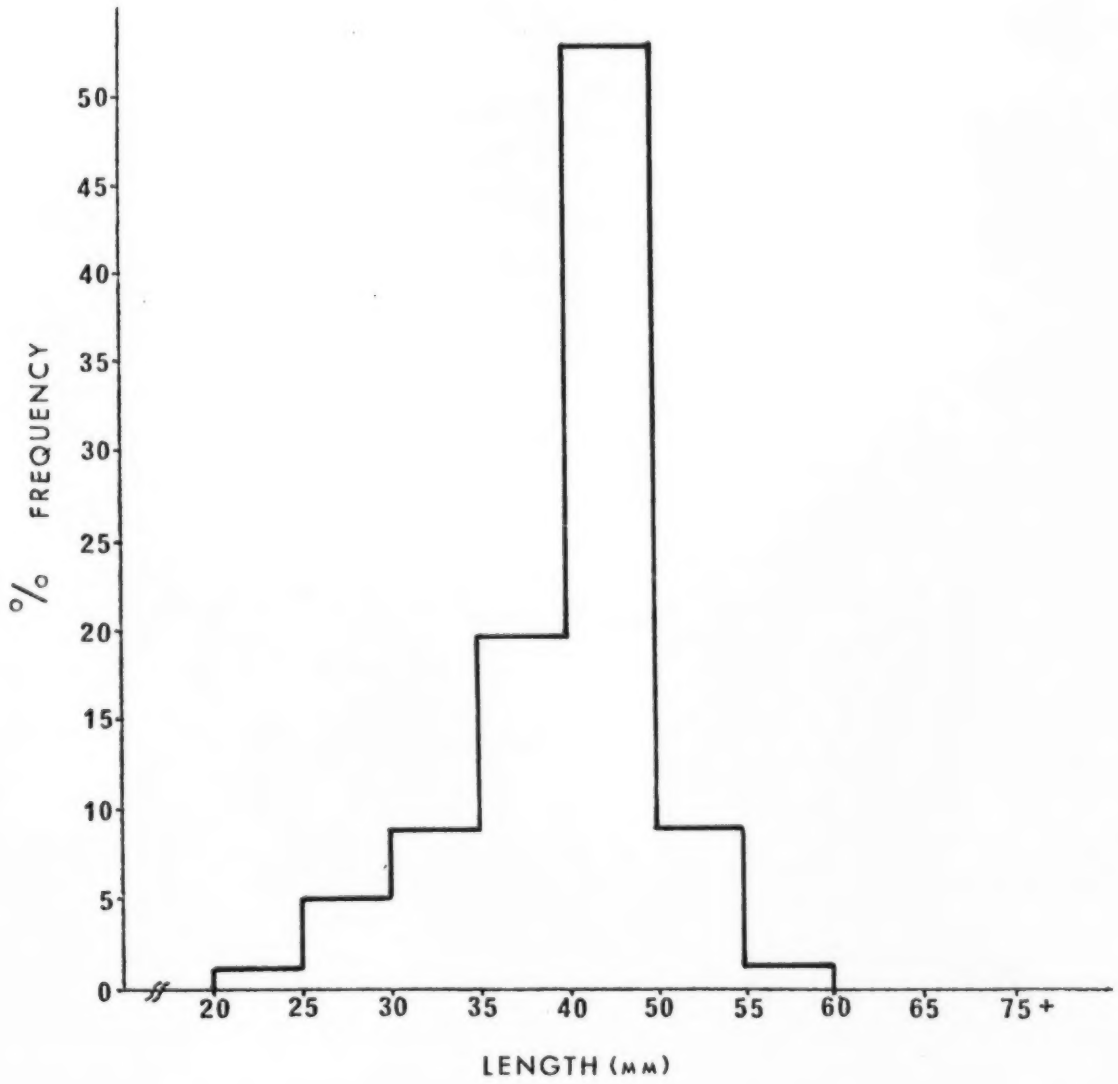

Figure 29. Size-frequency distribution, Magaguadavic River South, Section II.

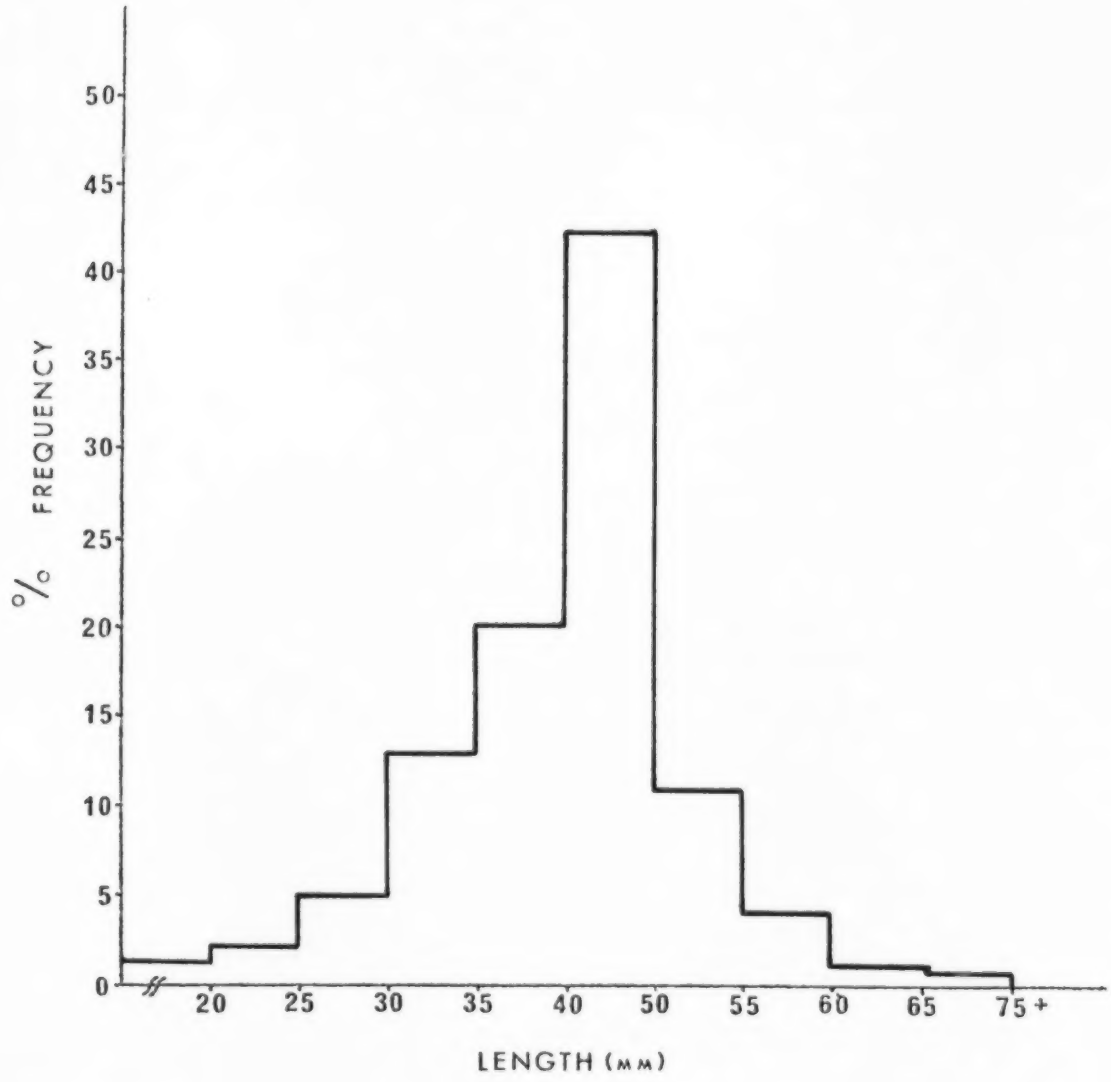

Figure 30. Size-frequency distribution, Magaguadavic River South, Section III.

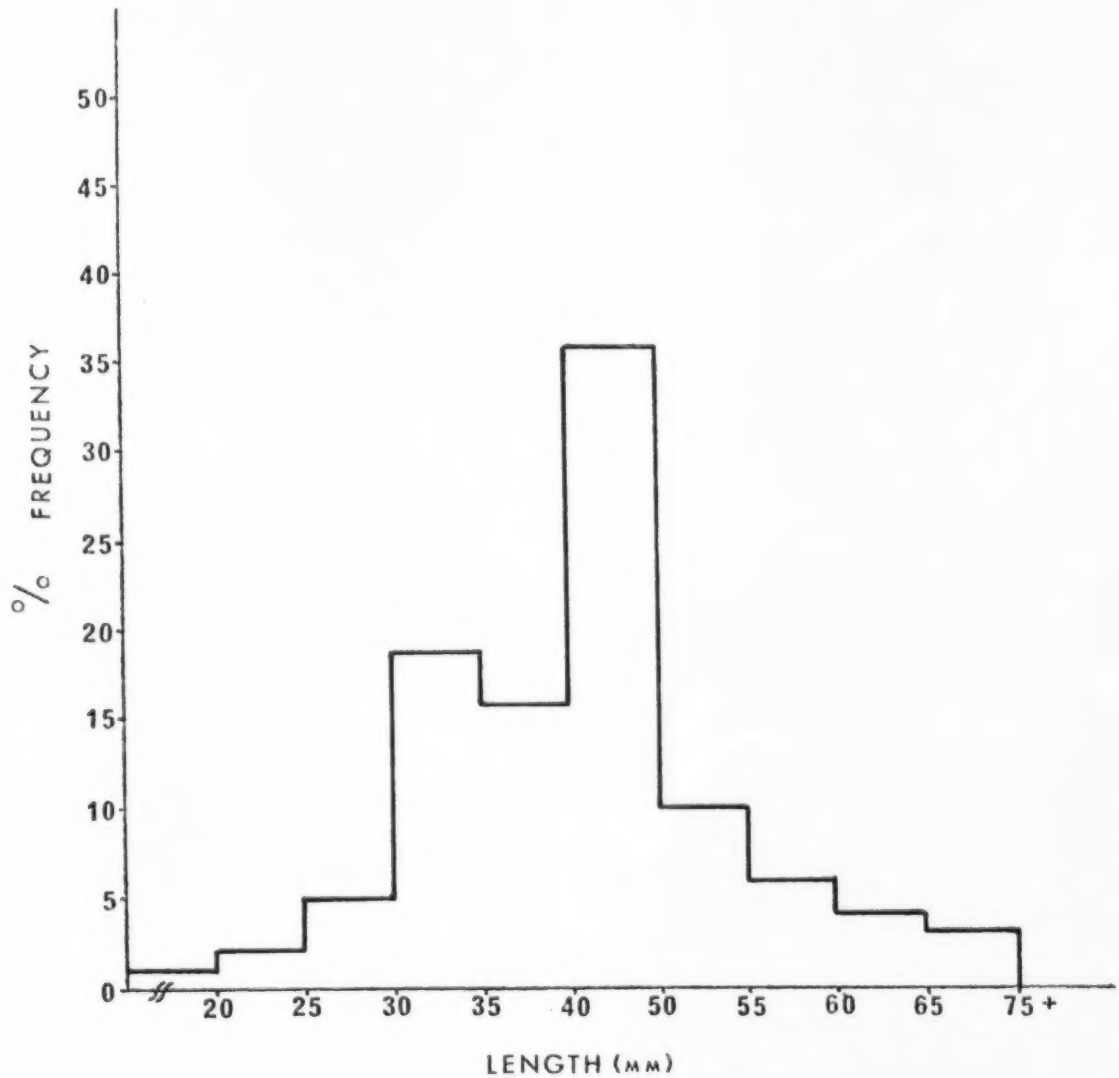

Figure 31. Size-frequency distribution, Magaguadavic River South, Section IV.

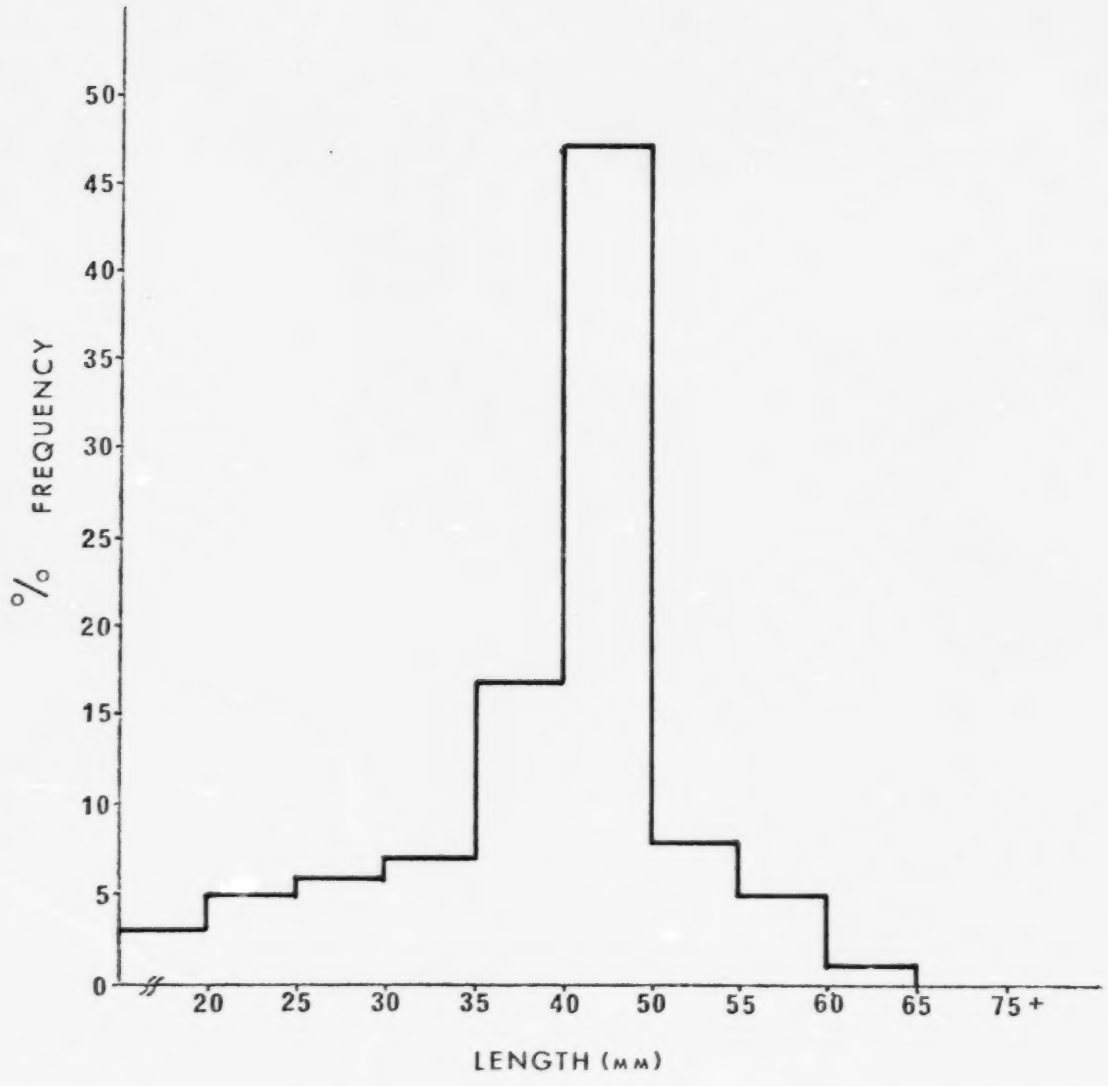

Figure 32. Size-frequency distribution, Magaguadavic River South, Section V.

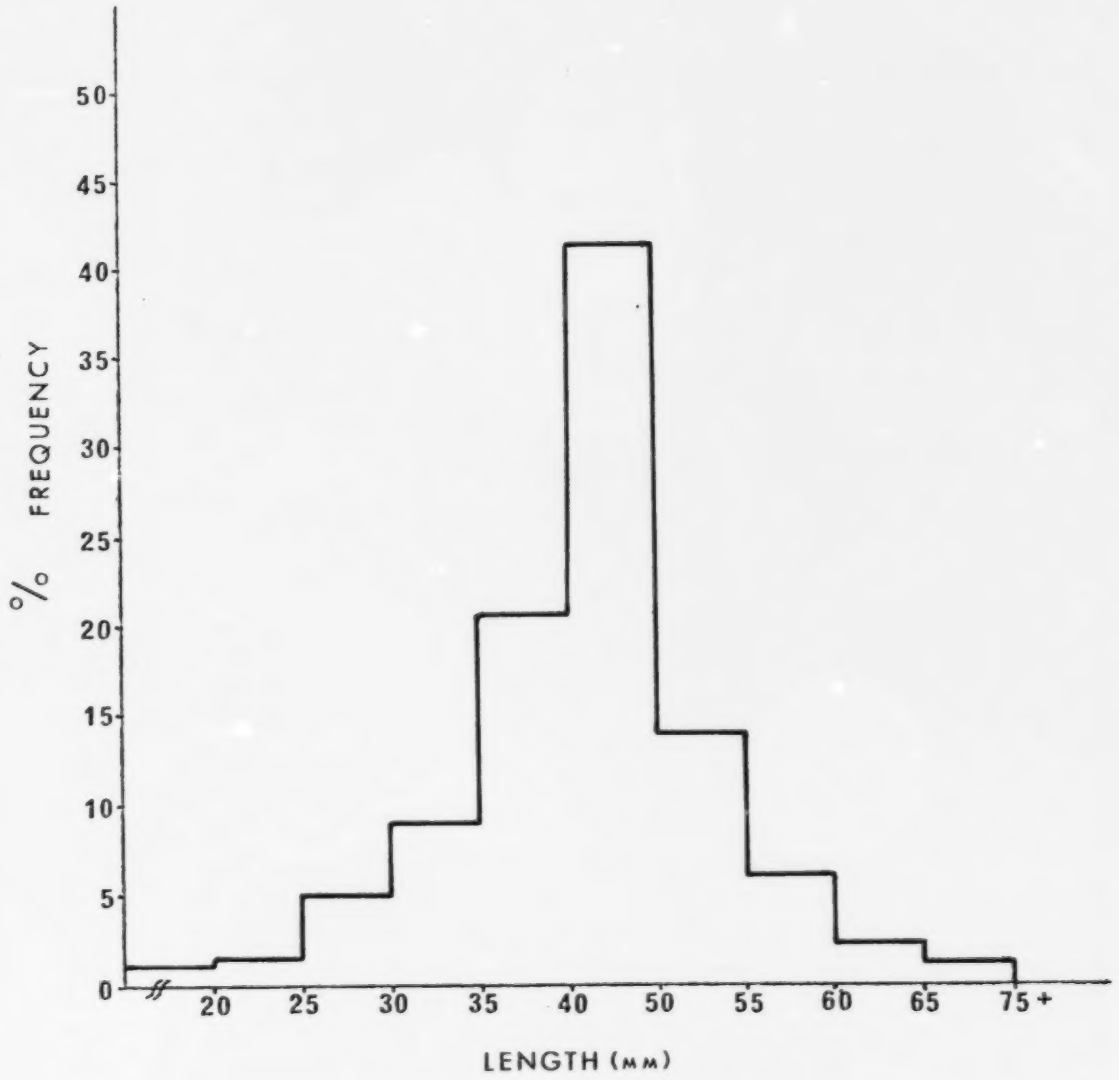

Figure 33. Size-frequency distribution, Magaguadavic River South, Section VI.

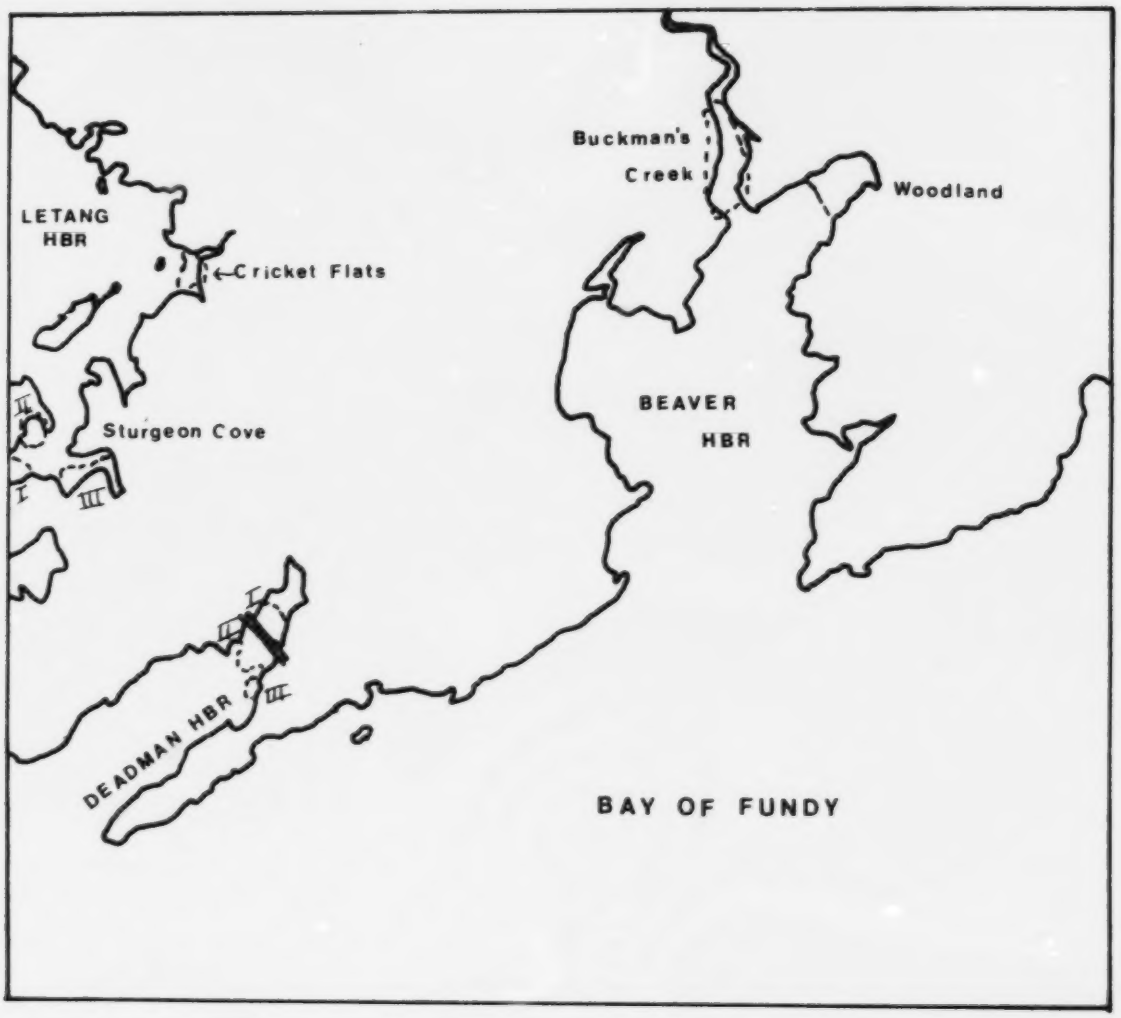

Figure 34. Areas surveyed in Letang Harbour, Deadman Harbour, and Beaver Harbour. Scale 1:50,000.

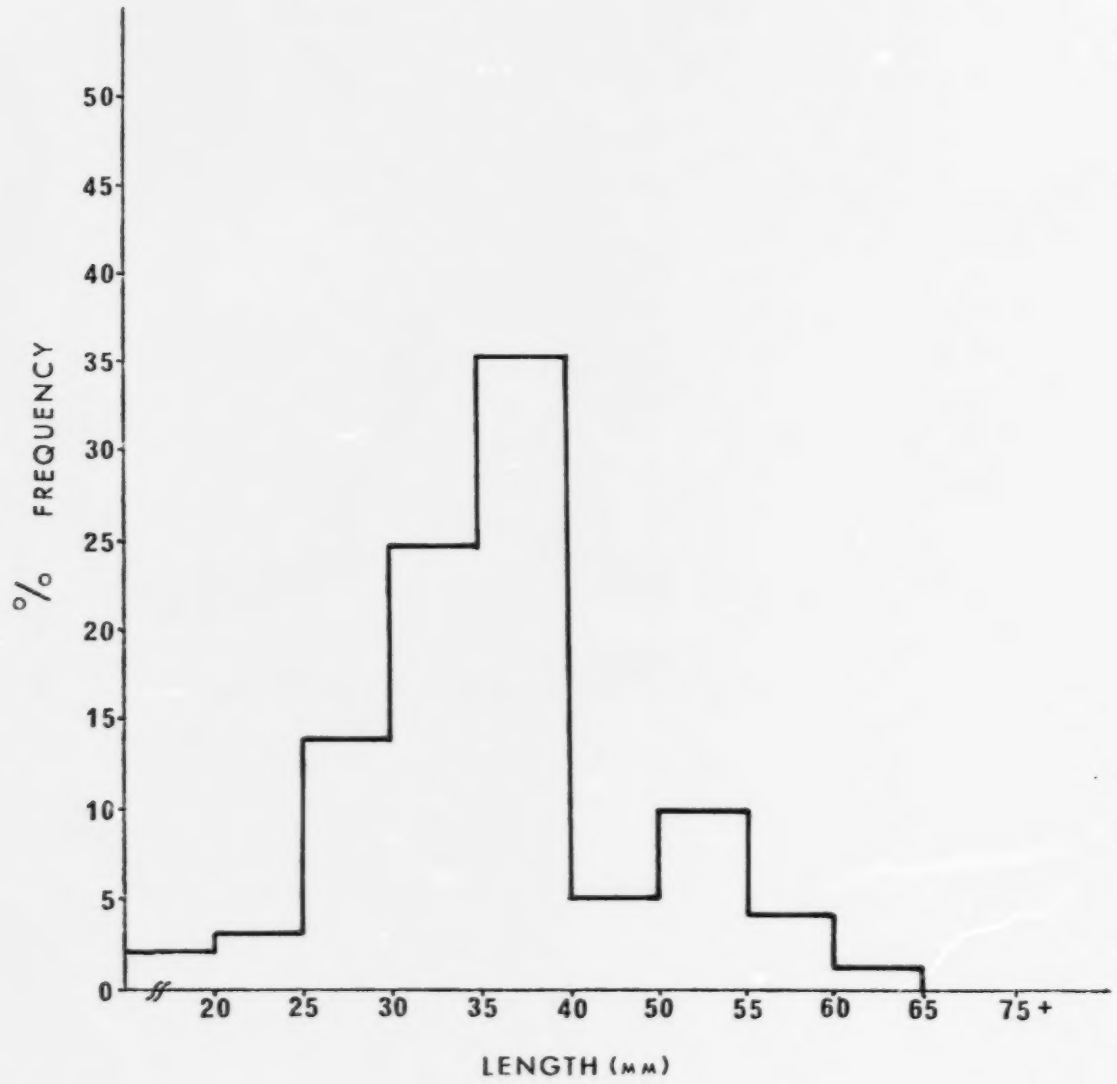

Figure 35. Size-frequency distribution, Cricket Flats.

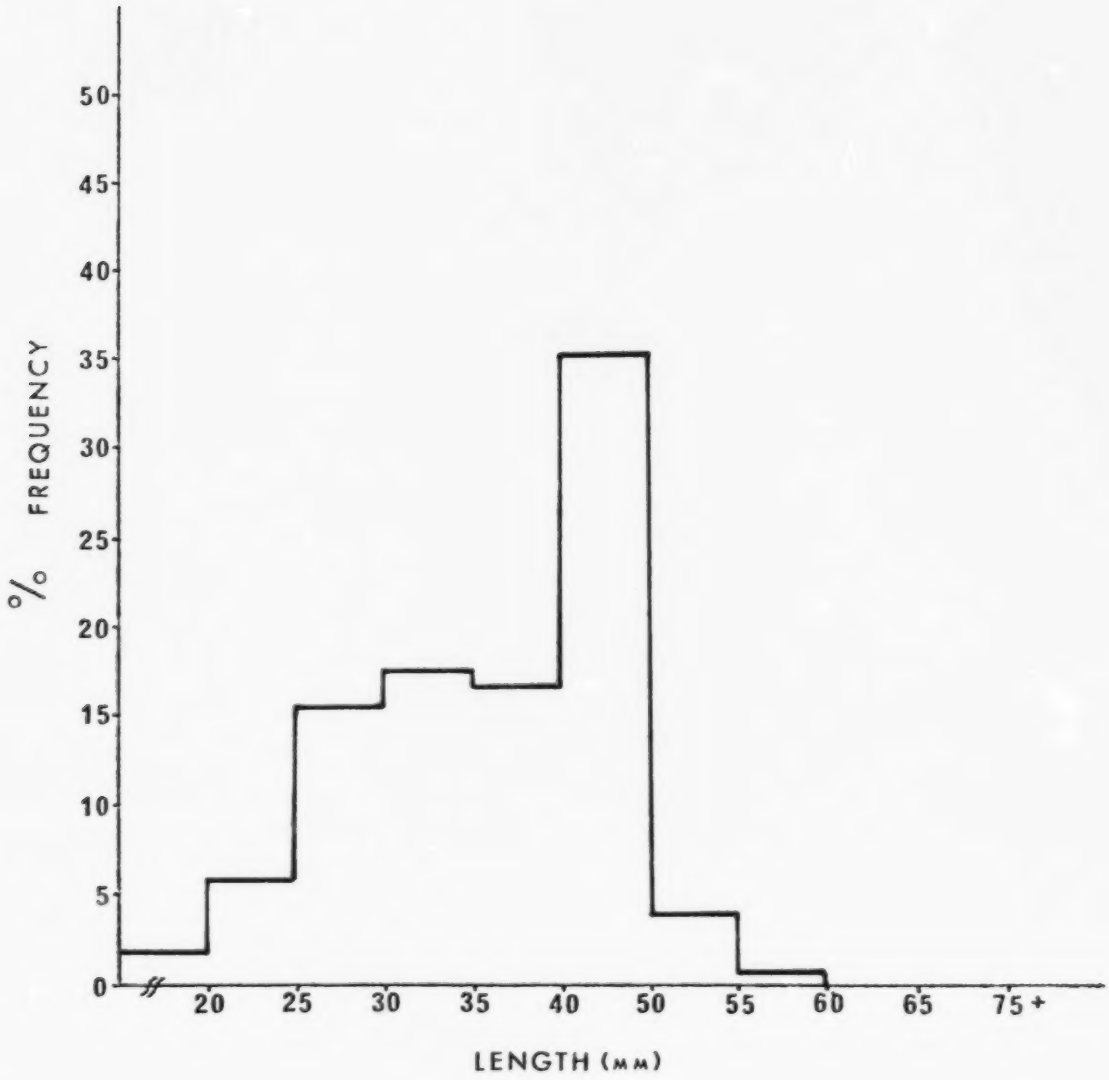

Figure 36. Size-frequency distribution, Sturgeon Cove, Section I.

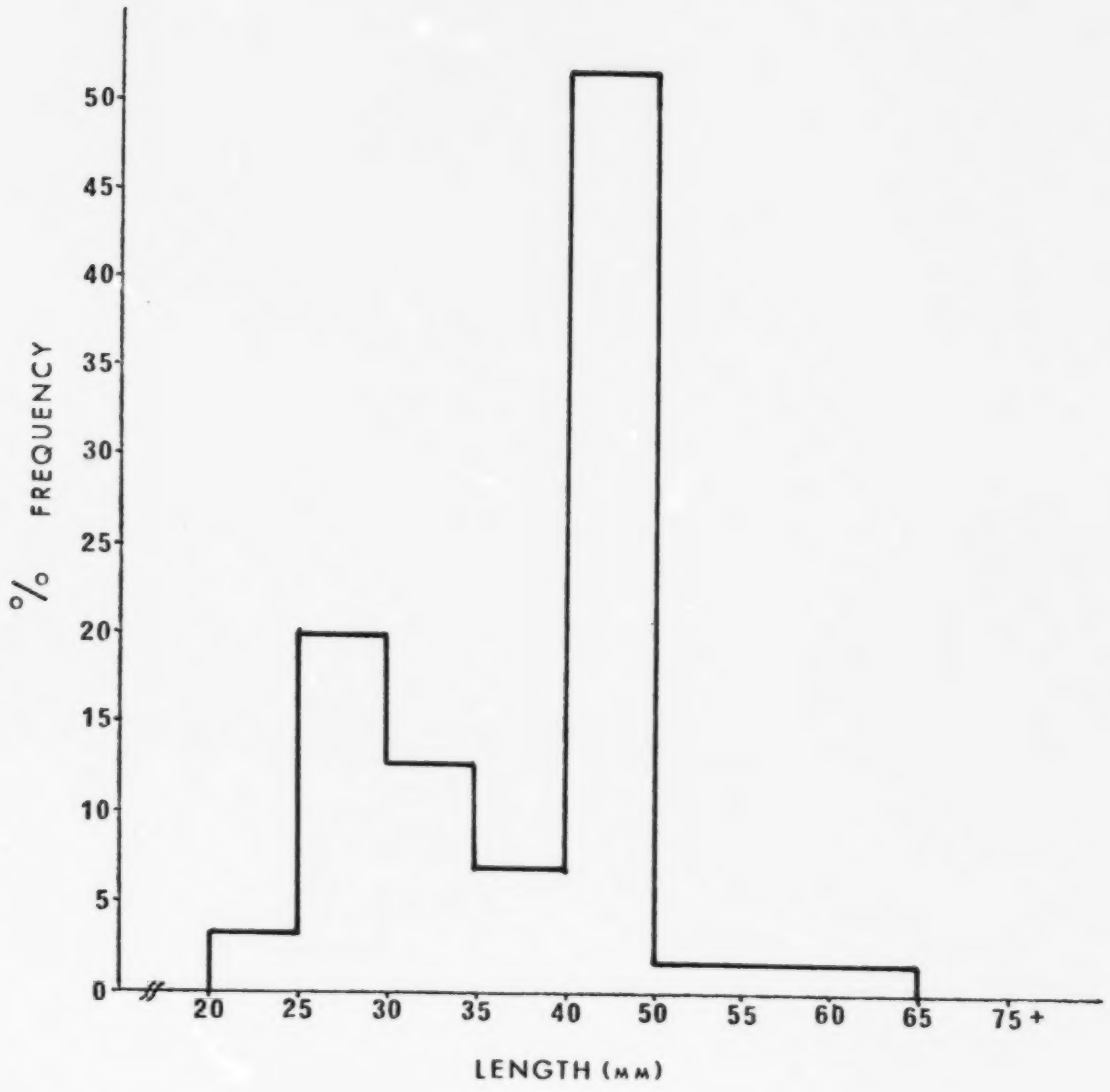

Figure 37. Size-frequency distribution, Sturgeon Cove, Section II.

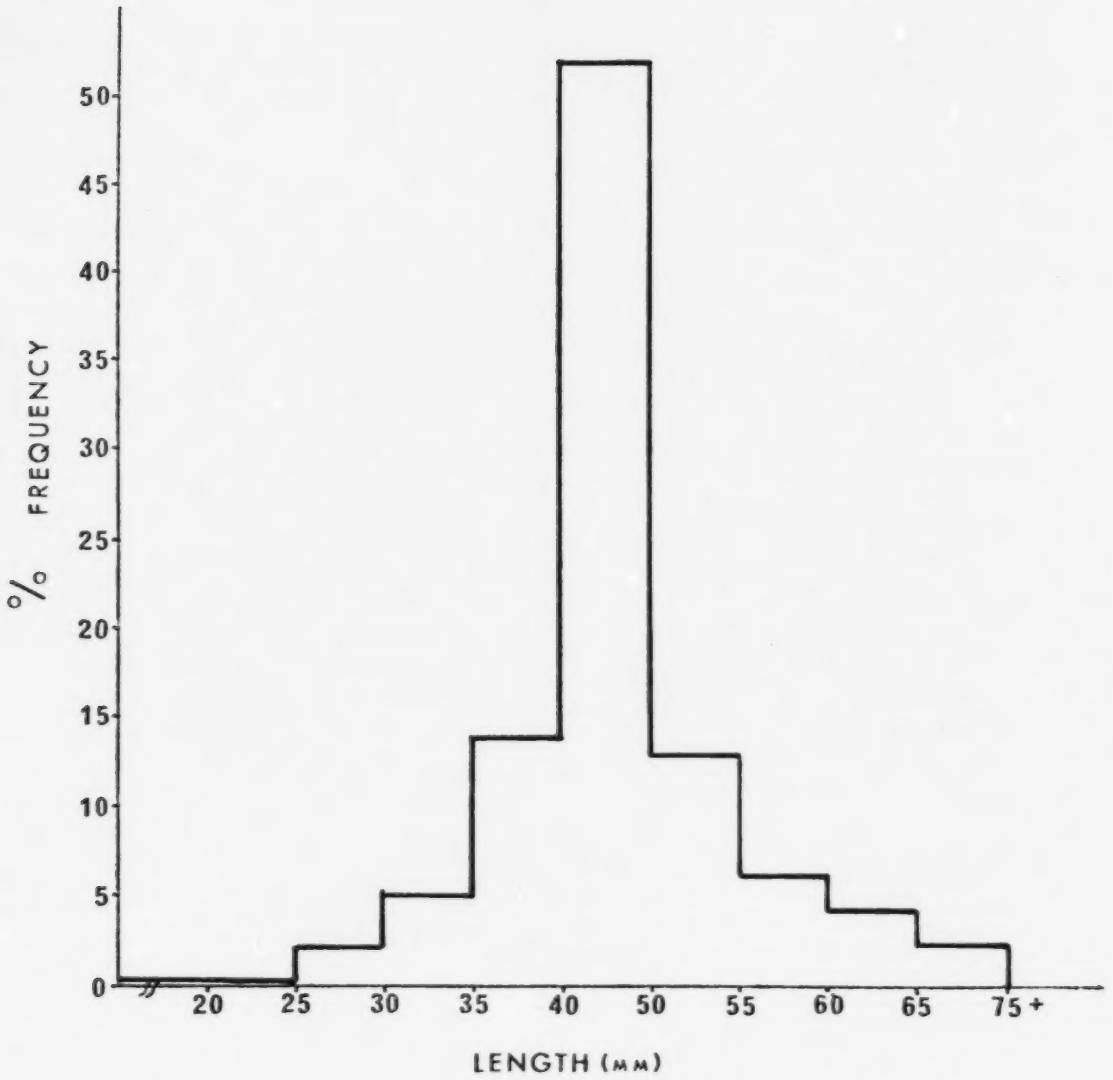

Figure 38. Size-frequency distribution, Sturgeon Cove, Section III.

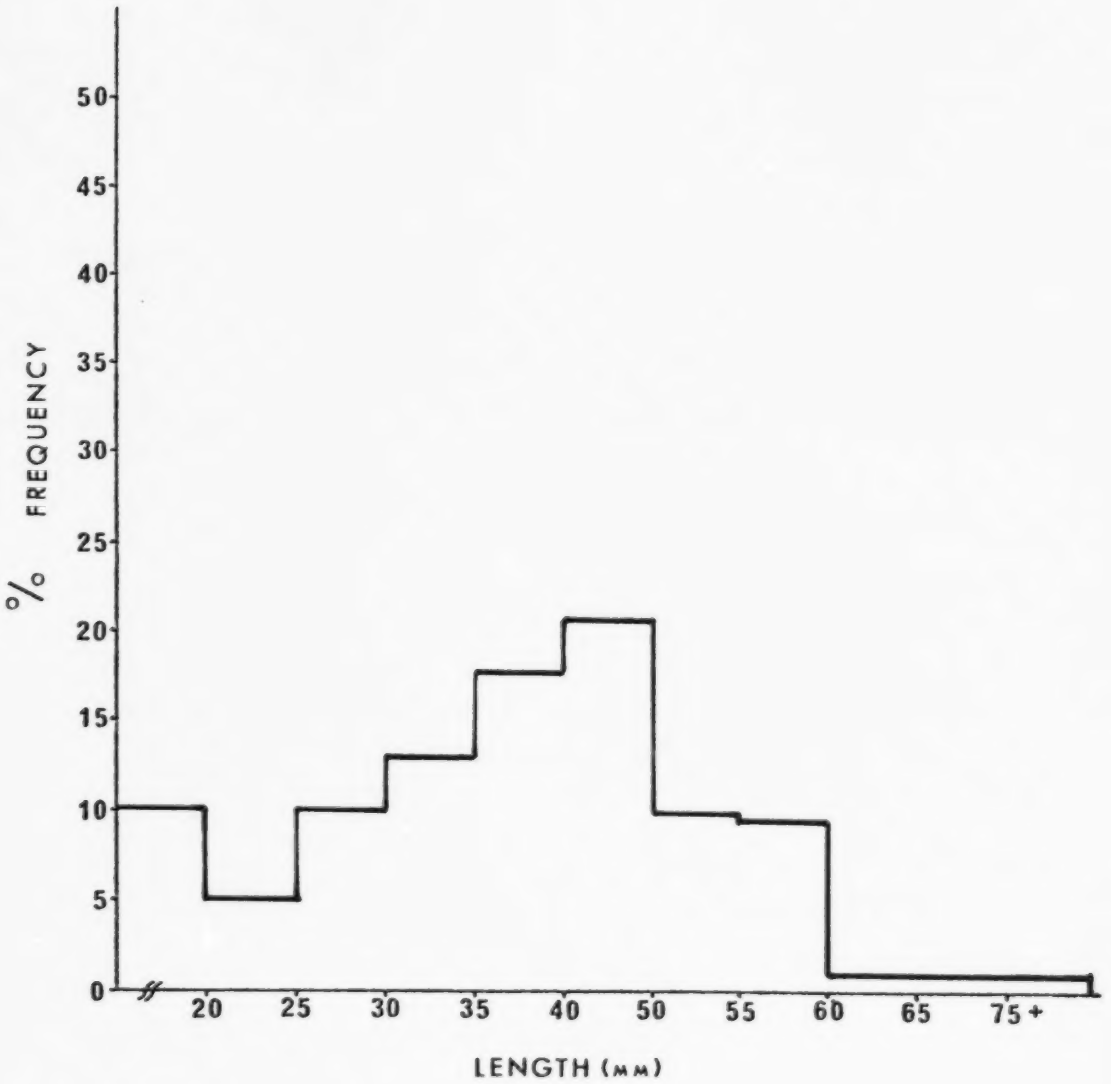

Figure 39. Size-frequency distribution, Deadman Harbour, Section I.

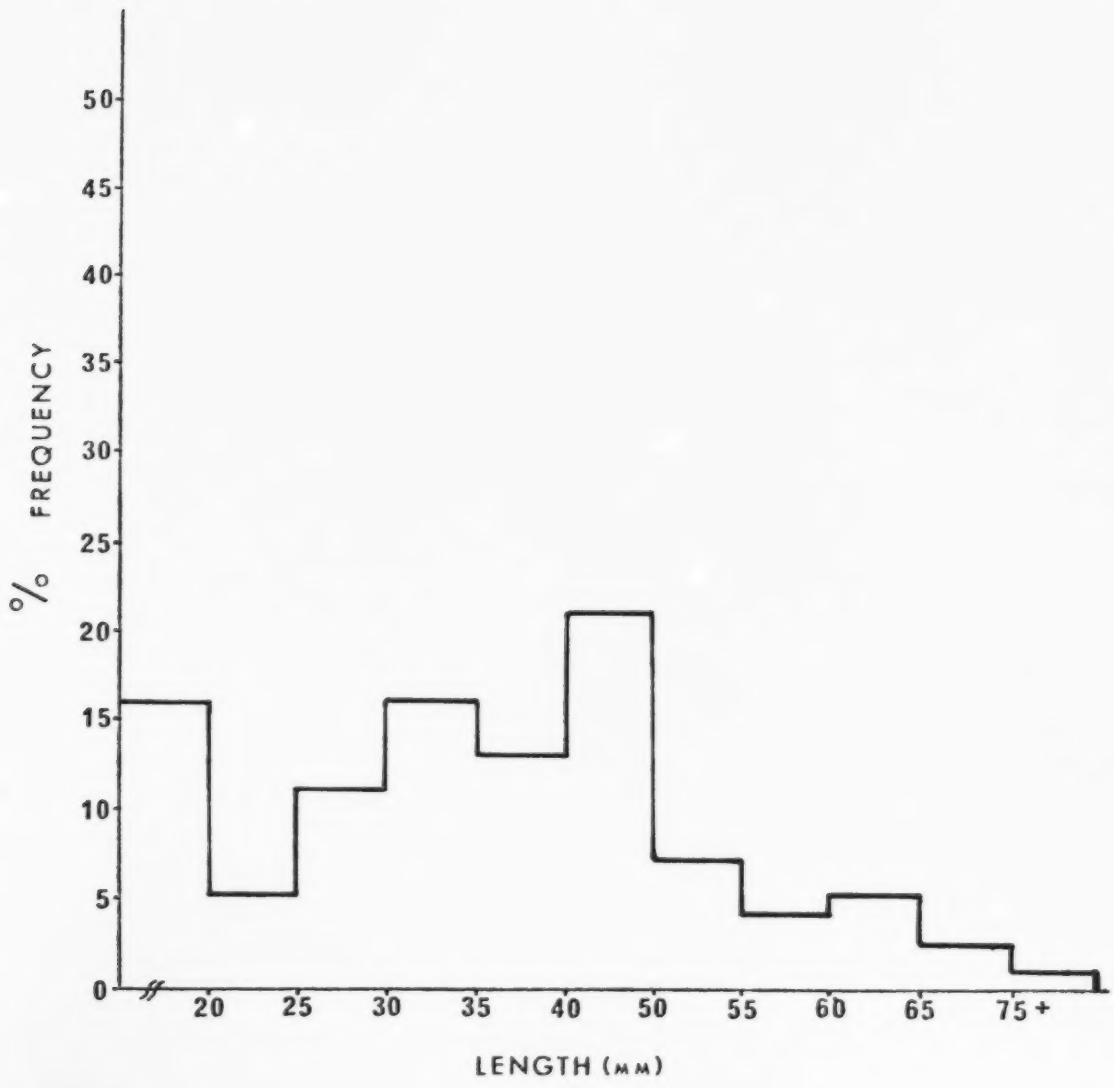

Figure 40. Size-frequency distribution, Deadman Harbour, Section II.

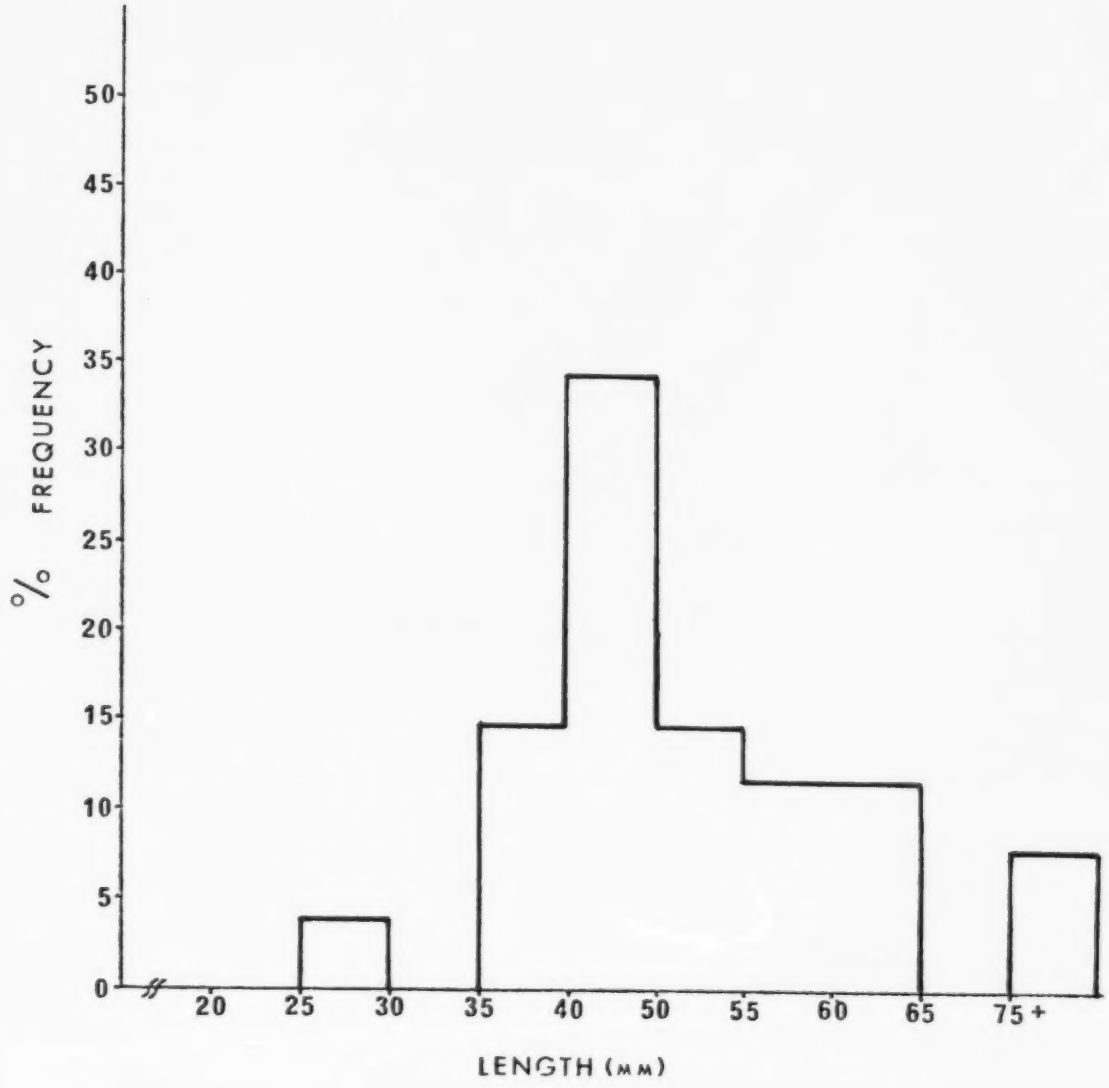

Figure 41. Size-frequency distribution, Deadman Harbour, Section III.

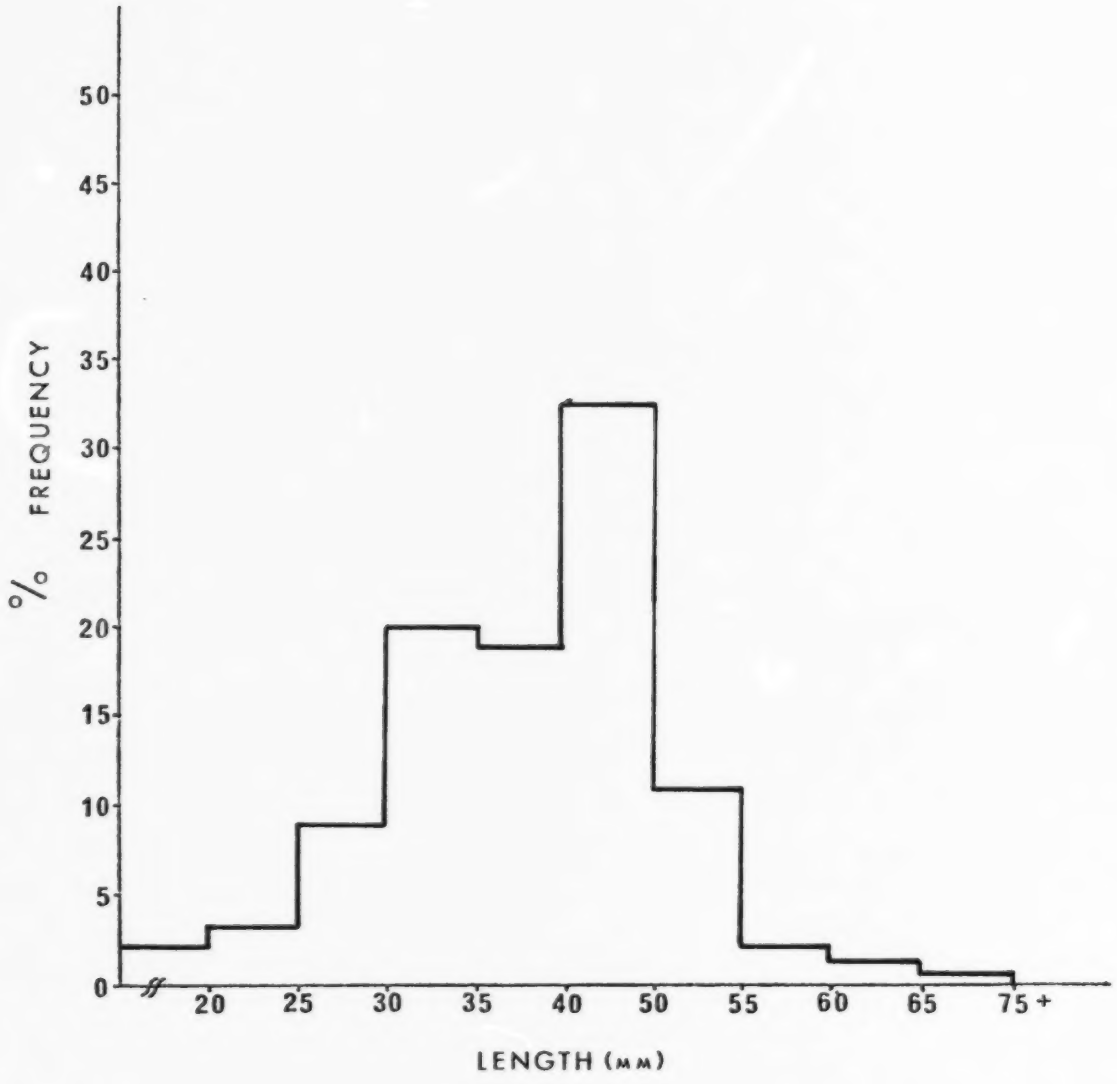

Figure 42. Size-frequency distribution, Buckman's Creek.

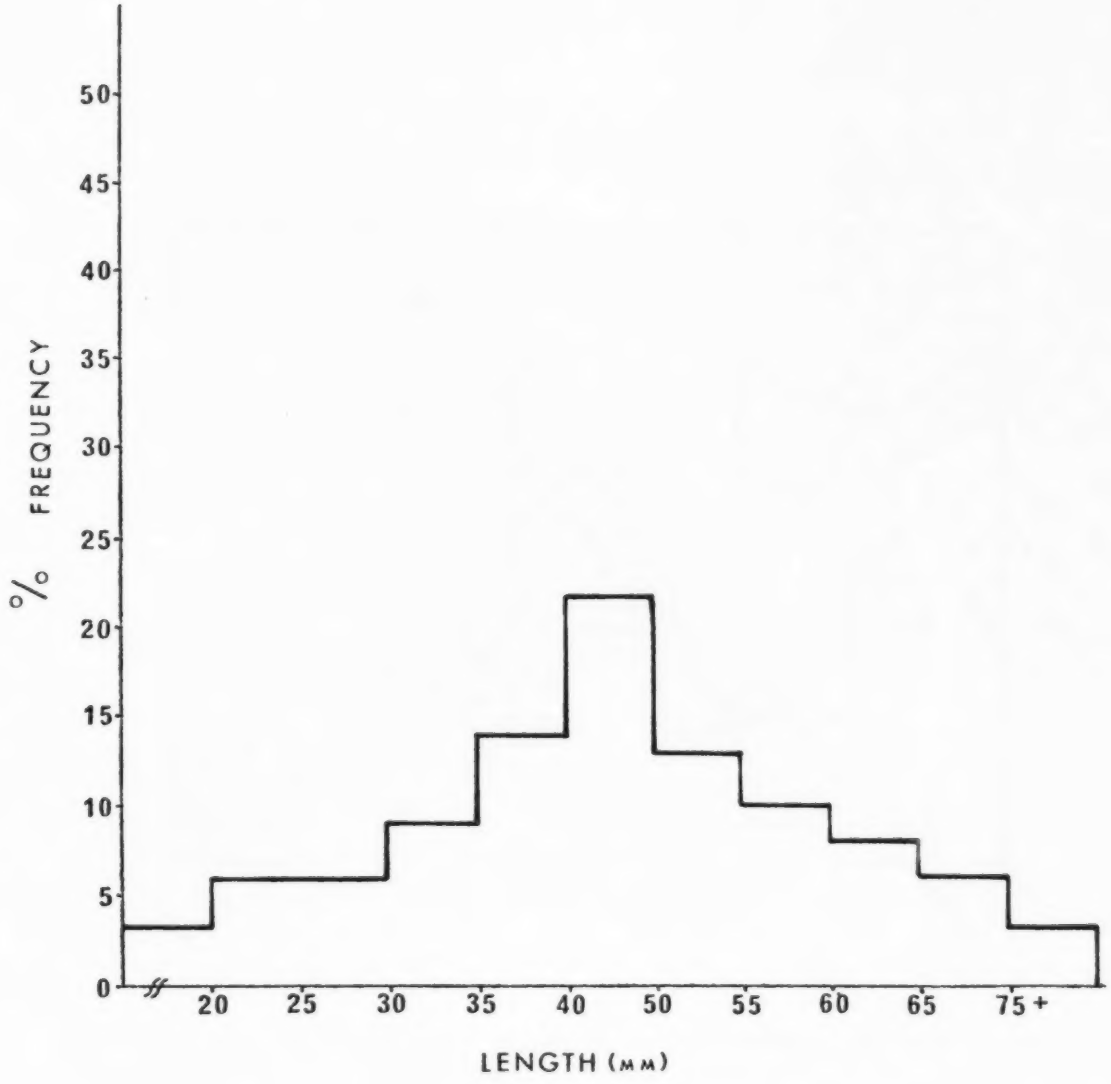

Figure 43. Size-frequency distribution, Woodland

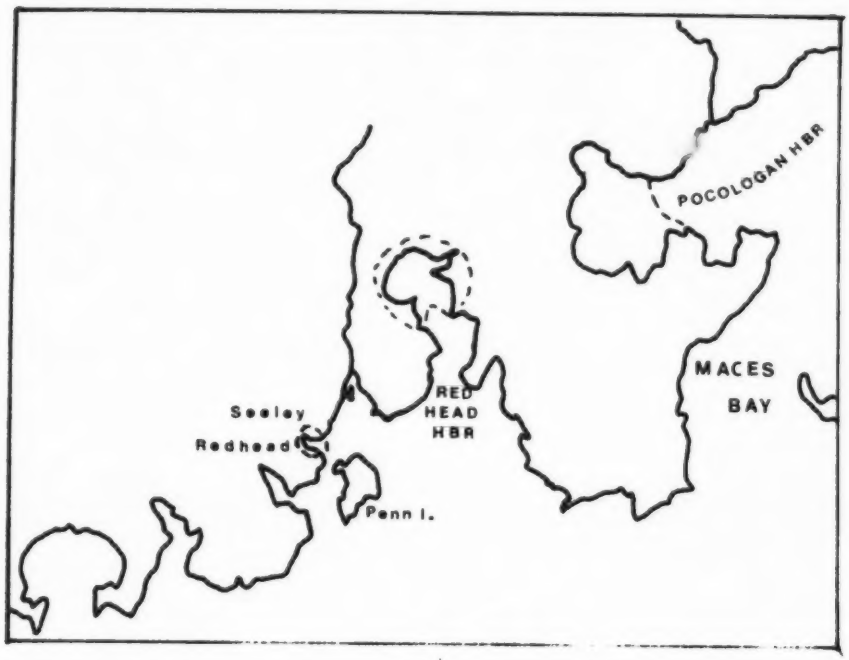

Figure 44. Survey locations in Redhead Harbour and Maces Bay. Scale 1:50,000.

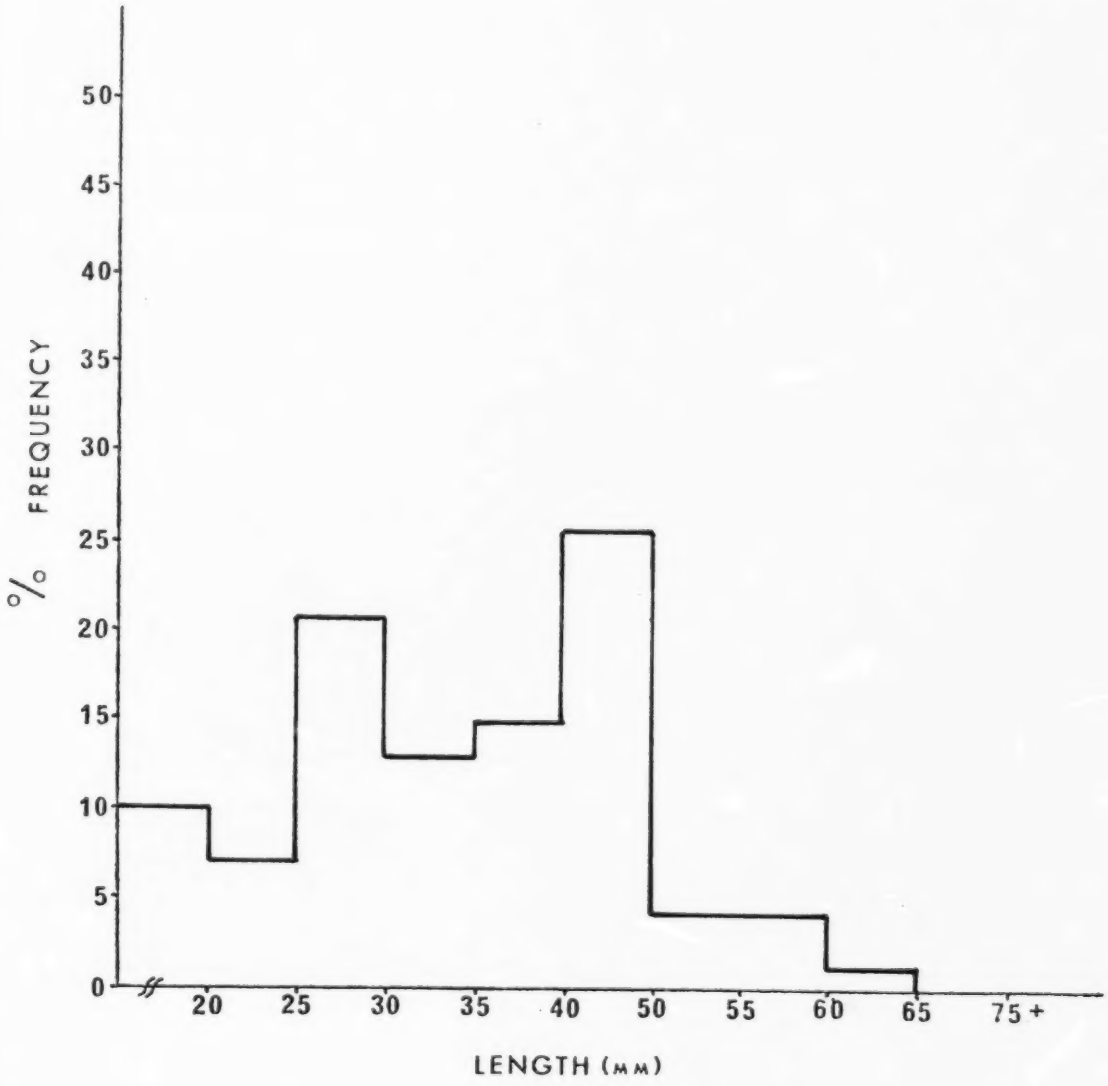

Figure 45. Size-frequency distribution, Seeley Redhead.

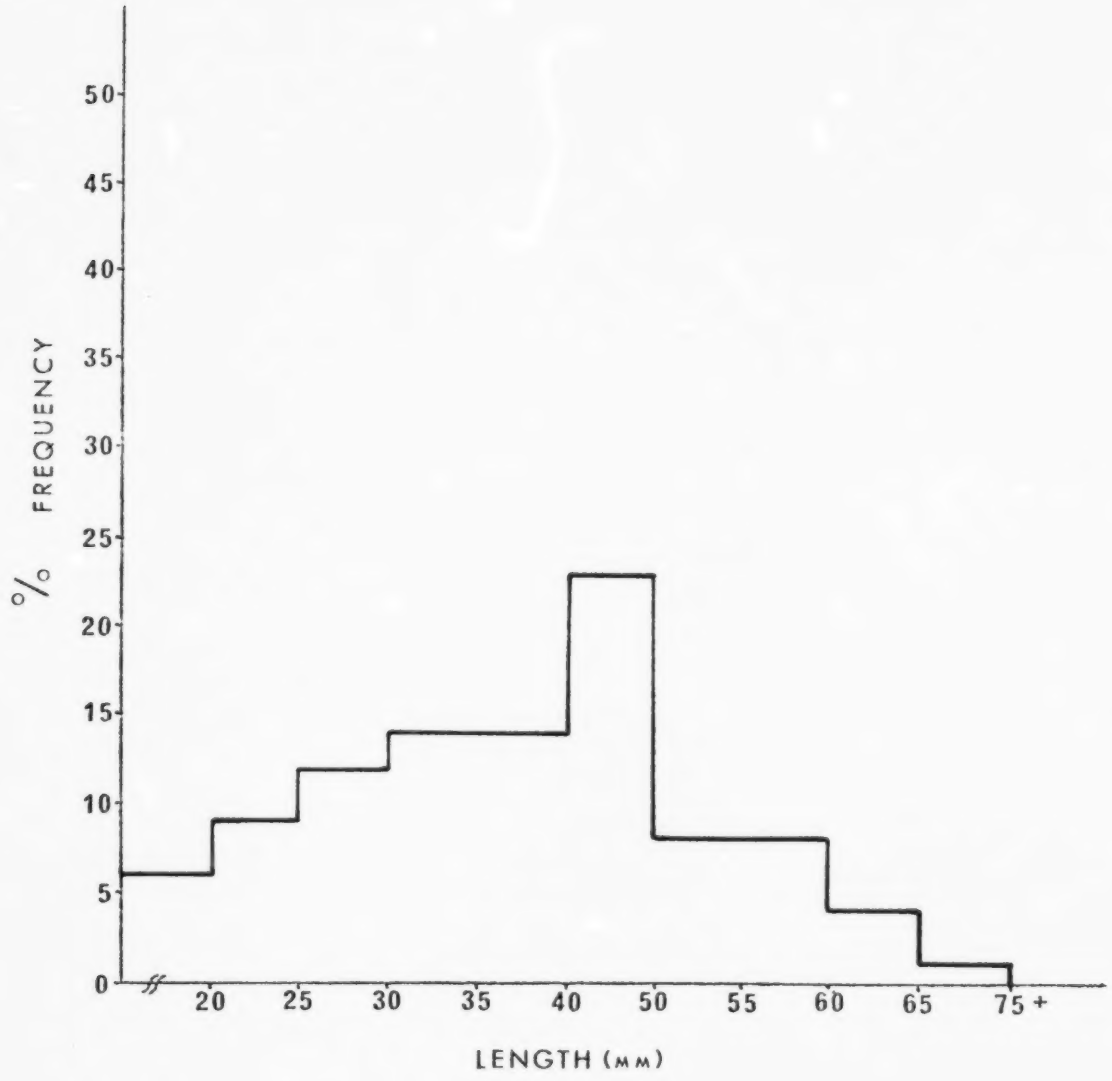

Figure 46. Size-frequency distribution, Redhead Harbour.

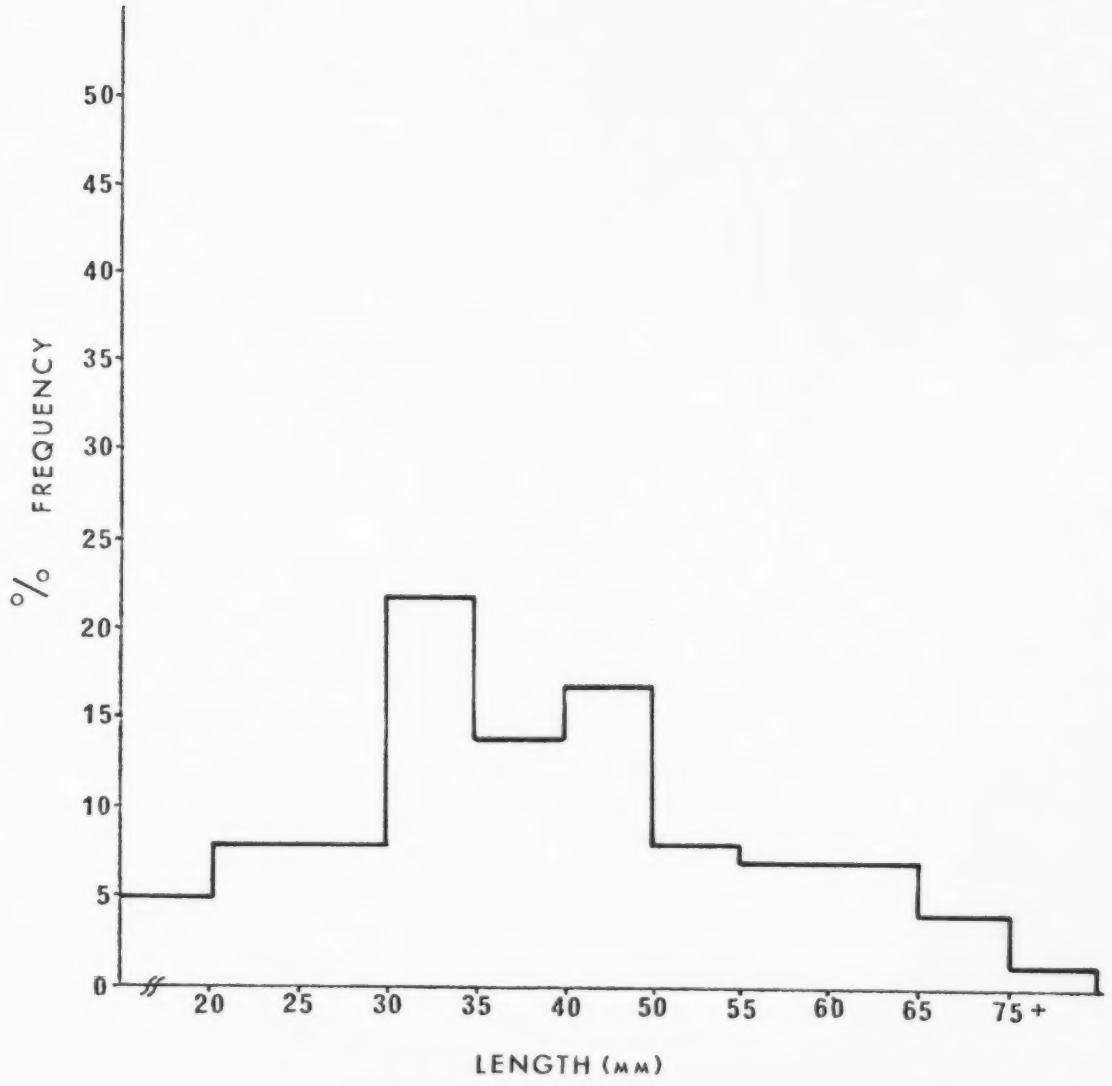

Figure 47. Size-frequency distribution, Pocologan Harbour.